Aviation Week
and Space Technology

October 31, 1960

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United Aircraft Ion Engine

SOLID PROPELLANT ROCKET POWER

Storable, shippable, ready as a rifle bullet—that's today's solid rocket engine. Since 1942, Aerojet-General has delivered over 700,000 solid rockets to the Armed Services, with an average engine reliability of more than 99.95%.

In the sixties, as in the forties, Aerojet stands foremost in the solid rocket field. Our Solid Rocket Plant near Sacramento, California, is the nation's largest facility for the development and production of solid rocket power plants.

With a propellant capability measured in millions of pounds per month, the Solid Rocket Plant is providing reliable rocket power for the nation's major missile programs.

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Solid Rocket Plant

Aerojet-General
CORPORATION
Sacramento, California

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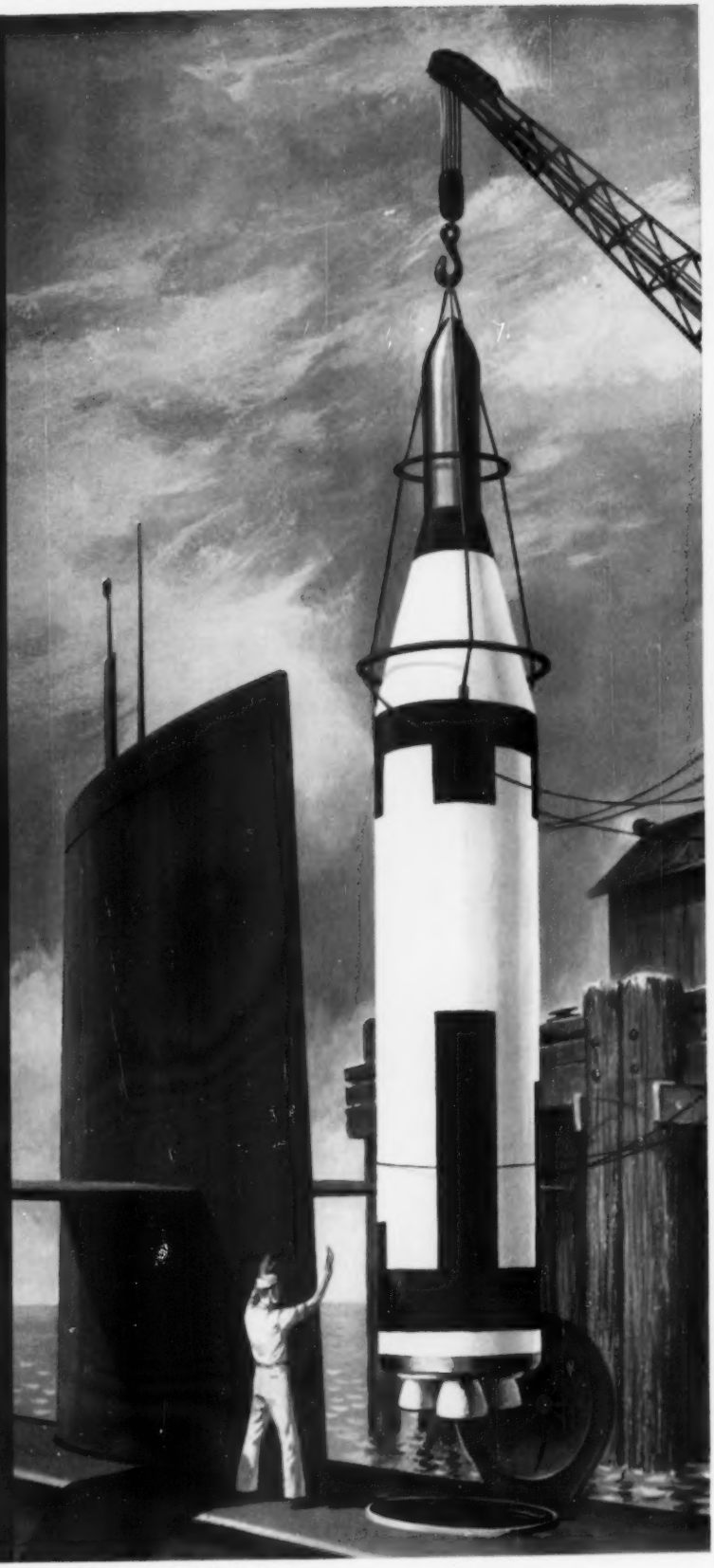
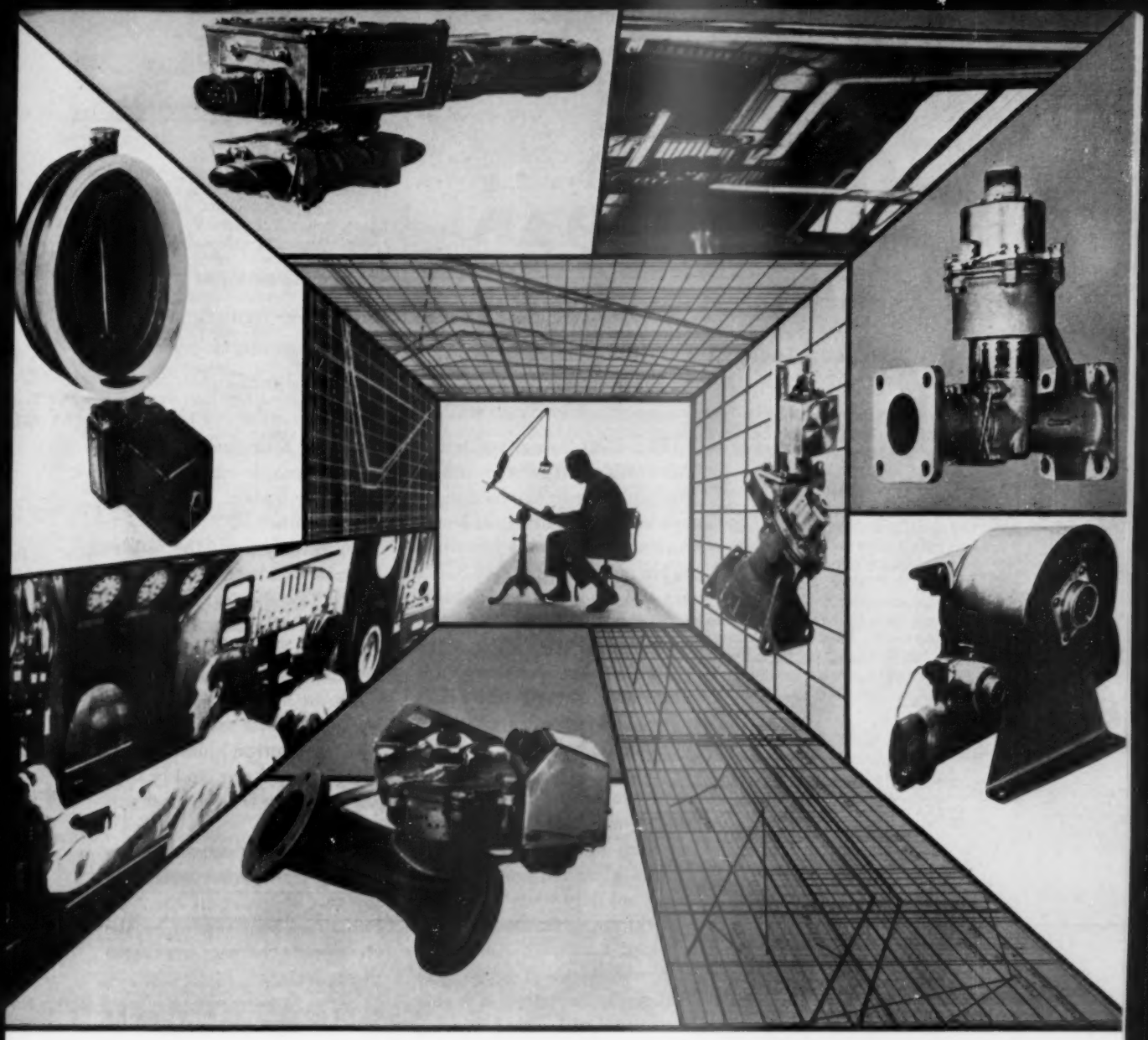


Engineers, scientists—investigate outstanding opportunities at Aerojet



Why pneumatic control engineers bring their "tough" valve problems to Hydro-Aire

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ENGINEERS: write D. B. Nickerson, Chief Engineer, regarding career opportunities at Hydro-Aire.

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Developers and producers of reliable control components, sub-systems and systems for the aircraft, missile, electronics and transportation industries

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Meet the newest member of the Sabre family

The T-39 Sabreliner is the Air Force's first twin-jet utility trainer. Now in production, it carries on the heritage of North American Aviation's renowned Sabre aircraft – the F-86 Sabre Jet and the F-100 Super Sabre.

Designed and built by North American for the Air Force, the versatile Sabreliner now is undergoing FAA certification that not only meets all military requirements but also civil specifications.

An important consideration in designing the Sabreliner was economy of operation. The result is a highly practical airplane not only when flying, but also during servicing and maintenance.

A wide range of capabilities makes the Sabreliner a highly versatile and hard-working member of today's Air Force. Carrying four students and a crew of two, it functions as a radar, navigation, or jet-proficiency trainer.

In performance, the Sabreliner rivals commercial jet airliners. Two Pratt and Whitney J-60 (JT-12) engines, with a thrust of 3000 pounds apiece, give it a cruising speed of 500 miles an hour at 40,000 feet, well above most weather. It can fly 1500 nautical miles without refueling, and can land or take off at the airport of almost any city.

With its wide range of capabilities, high performance, and low cost of operation, the T-39 Sabreliner promises to be the Air Force's compact workhorse of the jet age.

THE LOS ANGELES DIVISION OF NORTH AMERICAN AVIATION, INC.

THE T-39 SABRELINER

AVIATION CALENDAR

Nov. 14-15—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Olympic Hotel, Seattle, Wash.

Nov. 14-16—National Convention, National Aeronautics Assn., Indio, Calif.

Nov. 14-17—Sixth Annual Conference on Magnetism and Magnetic Materials, New Yorker Hotel, New York, N. Y.

Nov. 14-18—Flight Safety Foundation's 13th Annual International Air Safety Seminar, in cooperation with Aviation Crash Injury Research, Phoenix, Ariz.

Nov. 14-18—Western Engineering Conference and Exhibit, American Society of Tool and Manufacturing Engineers, Memorial Sports Arena, Los Angeles, Calif.

Nov. 14-19—Annual Convention, Air Line Pilots Assn., Carillon Hotel, Miami Beach, Fla.

Nov. 15-16—Symposium on Engineering Application of Probability and Random Function Theory, Purdue University, Lafayette, Ind.

Nov. 15-16—12th Annual Mid-America Electronics Conference, Institute of Radio Engineers, Hotel Muehlebach, Kansas City, Mo.

Nov. 15-17—36th Meeting, Aviation Distributors and Manufacturers Assn., Riviera Hotel, Palm Springs, Calif.

Nov. 15-17—Air Force-Navy-Industry Propulsion Systems Lubricants Conference (unclassified), Hilton Hotel, San Antonio, Tex.

Nov. 15-18—Annual Meeting, Executive Board of the Flight Engineers International Assn. (AFL-CIO), Sheraton-Atlantic Hotel, New York, N. Y.

Nov. 29—General Freight Traffic Management Seminar for Army, Navy, Air Force and Marine Corps transportation personnel of the Southwestern Traffic

(*Continued on page 6*)

AVIATION WEEK and Space Technology

October 31, 1960

Vol. 73, No. 18

Published weekly with an additional issue in December by McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. See panel below for directions regarding subscription or change of address. **Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Printed at Albany, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 11

ALC 603 Angle of Attack Computation and Display System

This system embodies engineering experience in angle of attack computational equipment that dates back to 1949. SM/I's Relative Wind Transducers became the first in the industry to satisfy military specifications. Elements of the system are pictured below; a vertical scale or clock-type indicator may be used for visual display. The design of the computer permits numerous variations with minimum modification. In all versions, this sub-system utilizes our Force Balance Mach Number Sensor, noted for its sensitivity and accuracy. As many as four data output servos each employing an SM/I transistorized amplifier can be provided in the unit without altering its exterior configuration. The gear train will operate various combinations of pots, synchros and other output devices. Normally, two SM/I relative wind transducers are used. One measures indicated angle of attack; the other measures angle of side-slip. After Mach number and side-slip corrections are made in the compensator assembly, the output function is the True Angle of Attack.

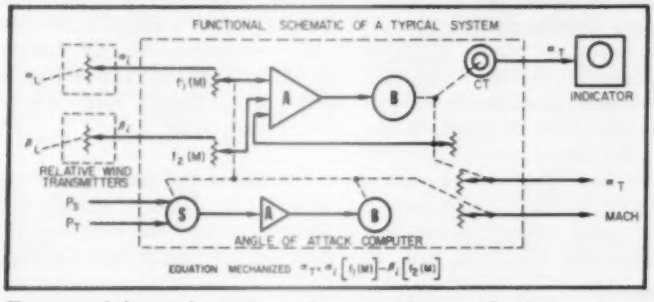
General Specifications

Operating range:
Angle of Attack ..... 50°
Angle of Yaw ..... 50°
Airspeed ..... 200 knots to 600 knots
Altitude ..... —1000 ft. to 60,000 ft.

Accuracy: ±¼°

Electrical Power Requirements: 115V, 400 cycle @ 2.5 amps (including vane heaters)

Computer Size: 8⅜"x5½"; weight, 7 lbs. (including shock mount)



For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

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- Mechanically Locked Stem
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- Positive Clamp-up
- Full Grip Range
- Complete Hole Fill
- Positive Visual Inspection (Grip Marked on Head)

A-286 Stainless Steel—Monel—Aluminum

The Cherrylock* "2000" series team offers the finest, most adaptable aircraft rivets yet developed. Maximum joint strength and reliability are obtained by using the Standard Cherrylock and the Bulbed Cherrylock to cover the entire range of applications. The Bulbed Cherrylock for short grips and double dimple, the Standard Cherrylock in the longer grips. Both types are installed with the same H-610 series pulling head, using existing Cherry guns.

Higher joint strength allowables, close blind side clearance, and the widest grip range available—only with the Cherrylock Team—result in better fastening at lower cost. The Cherrylock Team provides the strongest mechanical lock—flush fracture rivet available. Positive visual inspection after installation—with grip length marked on the rivet head—is offered only by the Cherrylock Team.

* * *

For technical data on the Cherrylock Team of rivets, write Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

*Patent No. 2931532

CHERRY RIVET DIVISION

Townsend Company

In Canada: *Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario*

AVIATION CALENDAR

(*Continued from page 5*)

Region, Adolphus Hotel, Dallas, Tex.

Dec. 5-8—15th Annual Meeting and Astronautical Exposition, American Rocket Society, Shoreham Hotel, Washington, D. C.

Dec. 6-8—Annual Meeting, National Aviation Trades Assn., Oklahoma-Biltmore, Oklahoma City, Okla.

Dec. 12-15—Atomic Industry Exhibition, California Masonic Memorial Temple, San Francisco, Calif., concurrent with the Atomic Industrial Forum's Annual Conference (Fairmont Hotel) and the American Nuclear Society's Winter Meeting (Hotel Mark Hopkins).

Dec. 13-15—Tenth Annual Eastern Joint Computer Conference, Hotel New Yorker and Manhattan Center, New York, N. Y. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Assn. for Computing Machinery.

Dec. 17—24th Wright Brothers Lecture, Natural History Bldg., Smithsonian Institution, Washington, D. C.

Dec. 26-31—127th Meeting, American Association for the Advancement of Science, New York, N. Y.

Dec. 28-30—Seventh King Orange International Model Plane Meet, Miami, Fla.

Jan. 9-11—Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Pa.

Jan. 9-13—International Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 16-18—Seventh Annual National Meeting, American Astronautical Society, Dallas, Tex.

Jan. 23-25—29th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 24.

Feb. 1-3—Second Winter Military Electronics Convention, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 1-3—Solid Propellants Conference, American Rocket Society, Salt Lake City, Utah.

Feb. 15-17—International Solid-State Circuits Conference, Institute of Radio Engineers, University of Pennsylvania campus and Sheraton Hotel, Philadelphia.

Mar. 5-9—Sixth Annual Gas Turbine Conference and Exhibit, American Society of Mechanical Engineers, Shoreham Hotel, Washington, D. C.

Mar. 9-10—Second Symposium on Engineering Aspects of Magnetohydrodynamics, University of Pennsylvania, Philadelphia, Pa.

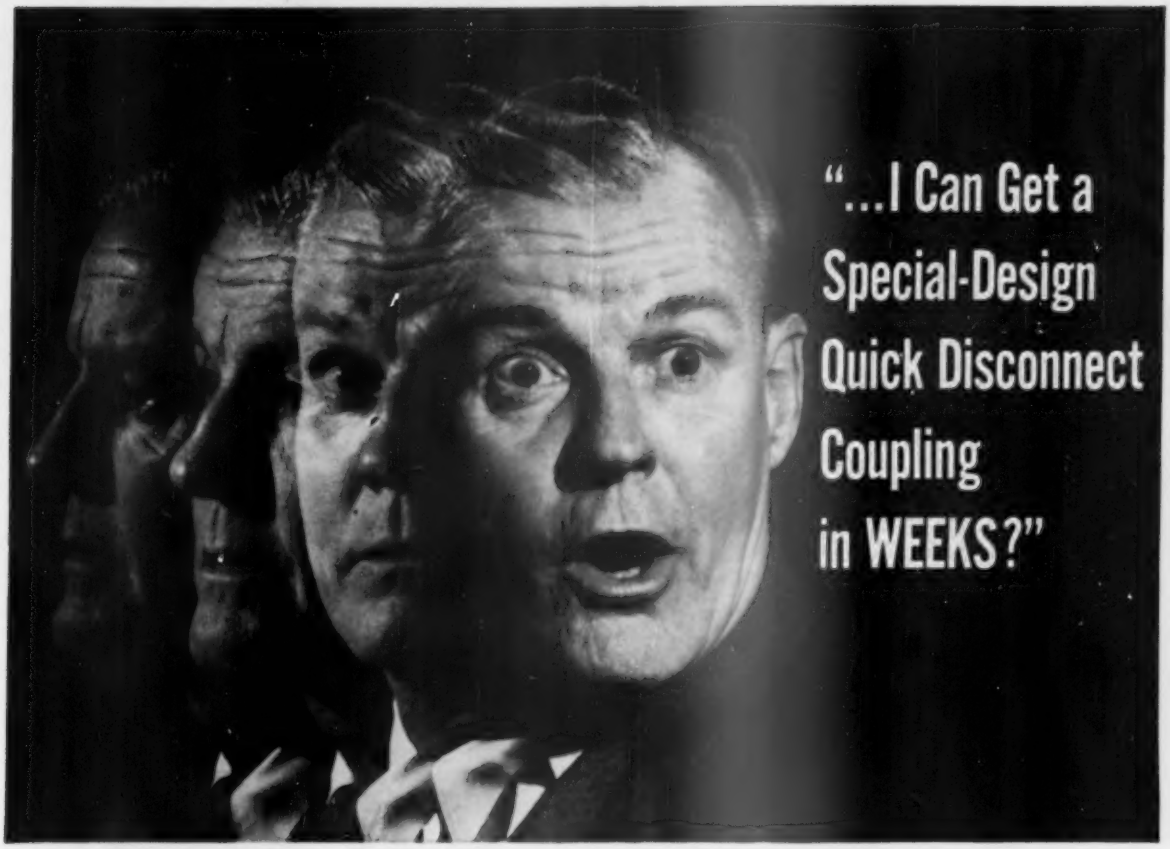
Mar. 9-10—Flight Propulsion Meeting, Institute of the Aeronautical Sciences, Cleveland, Ohio (classified).

Mar. 13-15—Flight Testing Conference, American Rocket Society, Los Angeles, Calif.

Mar. 13-16—Test, Operations and Support Conference, American Rocket Society, Biltmore Hotel, Los Angeles, Calif.

Mar. 16-18—Fifth National Conference on Aviation Education, Mayflower Hotel, Washington, D. C.

Mar. 20-23—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria Hotel, New York, N. Y.



YES, FROM AEROQUIP

For example, one customer required a special coolant coupling for an electronic countermeasures unit on the B-52. The coupling was to permit quick connection-disconnection of the electronics package without spillage of the silicone cooling fluid. Aeroquip received the requirement in March, 1960 . . . Prototype was completed in April! . . . Tests were finished by May 6!! . . . Delivery of production quantities in two sizes followed in short order.

At Aeroquip the design and development of special Quick Disconnect Couplings is a full time job by specialists. An entire section of our engineering department has no other job but to design special couplings, to provide a fast yet most economical solution to your application.

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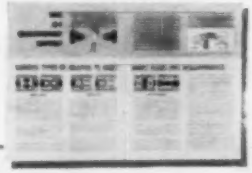

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Would you like to talk to a sales engineer about your application? ☐ Yes ☐ No

HIGH CLAMP-UP MEETS MACH 2 STRUCTURE NEEDS

hi-Lok®

Faster the speed, more varied the mission . . . the more critical are the structural requirements. Such is the Navy's newest all-weather, nuclear weapons carrying aircraft . . . the carrier-based A3J Vigilante.

Because of their excellent residual preload characteristics, Hi-Loks were selected for use throughout the A3J primary structure. The unique Hi-Lok torque-off feature produces a high, uniform clamp-up of high tensile sheet materials in *all* grip conditions. The installation method is smooth and quiet.

Inexpensive, lightweight, Hi-Lok tooling reduces worker fatigue and avoids the need for heavy squeezers or bulky pull-type equipment and their limitations in close quarters. In open areas, Hi-Loks can be installed at speeds up to 45 per minute.

Write or contact us for Hi-Lok technical and specification data.

ABOVE In strength and temperature areas, the A3J uses stainless steel Hi-Lok pins (125,000 psi shear or 220,000 psi tensile) with shanks made to .0005 tolerance; with stainless steel collars, these Hi-Loks can be used to 800°F. Other primary structure uses alloy steel Hi-Lok pins (95,000 psi shear or 160,000-180,000 psi tensile) with shanks made to .001 min. as well as head heights to ±.001 tolerance.

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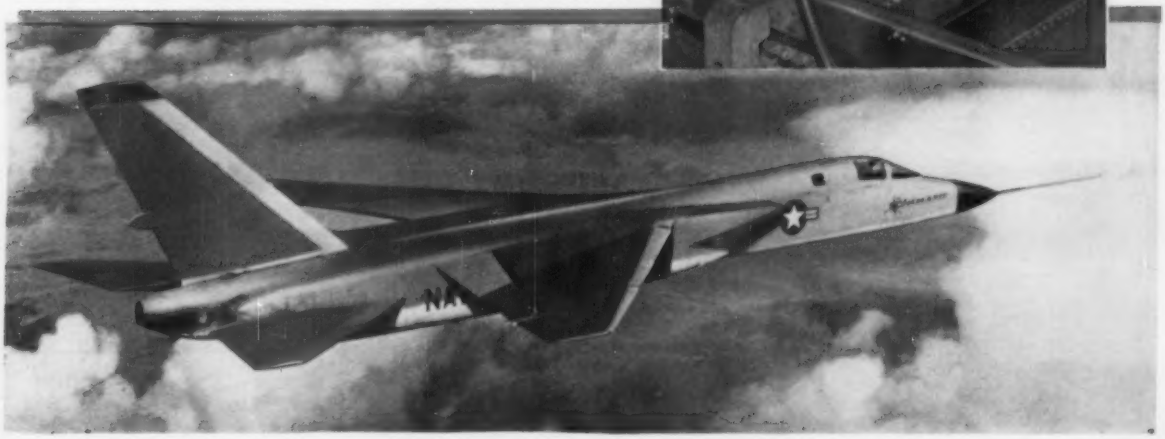
RIGHT Here Hi-Loks are being installed in the A3J rear fuselage with Hi-Lok right angle tooling adapted to a Ratchet Wrench Motor. Other Hi-Lok adaptor tooling is available in straight, extended and offset styles to overcome difficult or tight clearance conditions resulting from the unusual structural configurations of high performance airframes such as the Vigilante.

TRADEMARK REGISTERED. U.S. PATENTS 2,802,773, 2,927,491 AND 2,940,495. OTHER U.S. AND FOREIGN PATENTS GRANTED AND PENDING.



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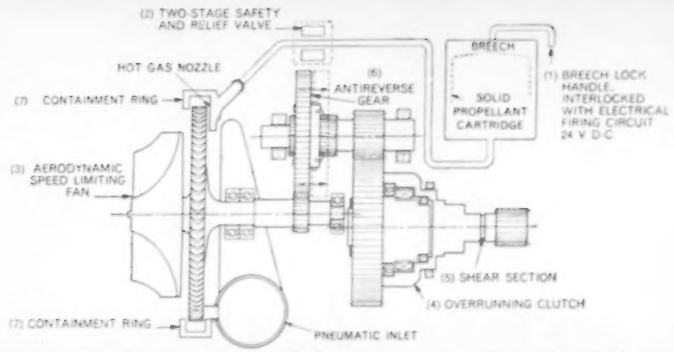
A major advance in safe three-way turbine engine starting

Sundstrand Cartridge-Pneumatic Starter



Schematic showing cascaded safety features. The two-stage safety and relief, (2) above, controls cartridge burn rate and assures consistent starting torques at all temperatures from -65° F to +160° F. The safety stage of the valve resets automatically.

Personnel and aircraft protection against destructive failure during starting and operation

	Cartridge	Pneumatic	Engine Overrun
(1) Breech Interlock	●		
(2) Safety and Relief Valve	●		
(3) Speed Limiting Fan	●	●	
(4) Overrunning Clutch			●
(5) Shear Section	●	●	●
(6) Antireverse Gear	●	●	●
(7) Containment Ring	●	●	●
	S A F E T Y		

The new universal Sundstrand Cartridge-Pneumatic Starter incorporates the most comprehensive fail-safe system ever designed for cartridge, ground cart compressed air, and cross-bleed air turbine engine starting. Complete protection against destructive failure, as illustrated above, insures the safety of personnel and aircraft.

First to cartridge start the TF-33 ducted fan engine for the B-52H, the starter also has been proved on the J-57 and J-75 engines and is readily adaptable to J-52 and J-79 engines. Its universal design makes the unit completely interchangeable for retrofit on the F-100, F-101, F-105, KC-135, and the B-52 series, replacing pneumatic starters. With minor changes this universal designed starter is adaptable to the F-104, B-58, and GAM-77 Hound Dog.

The Cartridge-Pneumatic Starter is backed by Sundstrand's experience and capabilities as the nation's leading supplier of aircraft secondary power systems. Detailed information is available upon request. Call our nearest office or write to the address below.

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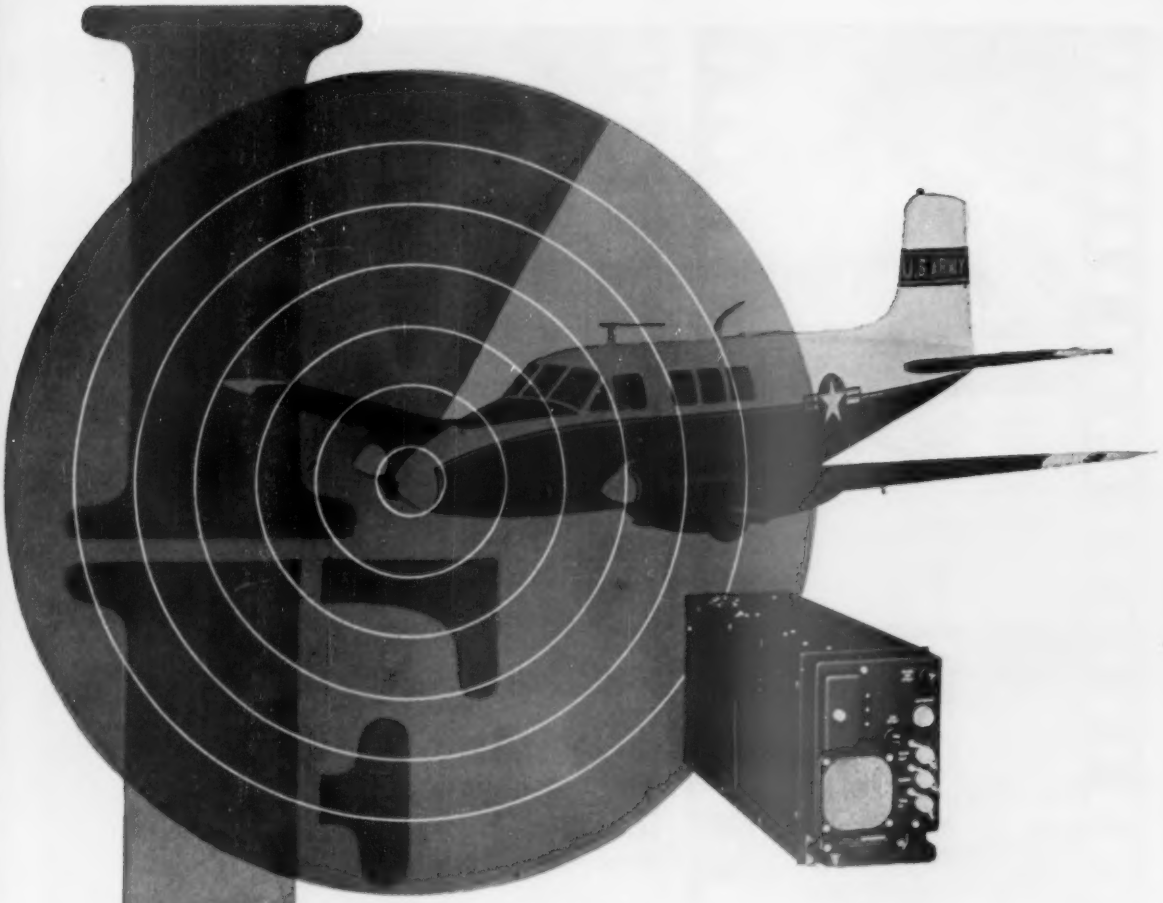

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safeguards Army aircraft

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12 E, first light copter to erect entire powerline; 40' poles, el. 5,000 ft.
34,500 lbs. of machinery to exploration mine in 8 hrs. mountain flying.
Microwave station on 4,000' ridge; all 8 tons material; 2 days flying.

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The next step rewrote the specs on what light utility helicopters can do. Capitalizing on the H-23D Raven's dynamic components with a 305 hp Lycoming engine's power, light helicopter "firsts" of the kind above were bound to happen. Similar profitable operations are flown every day, wherever there's an E.

That's why the 12 E has become first choice—it's the most economical helicopter purchase today.

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H-23D 250 hp *12 E 305 hp* *E4 320 hp* *Super E 340 hp*

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*Name available on request.

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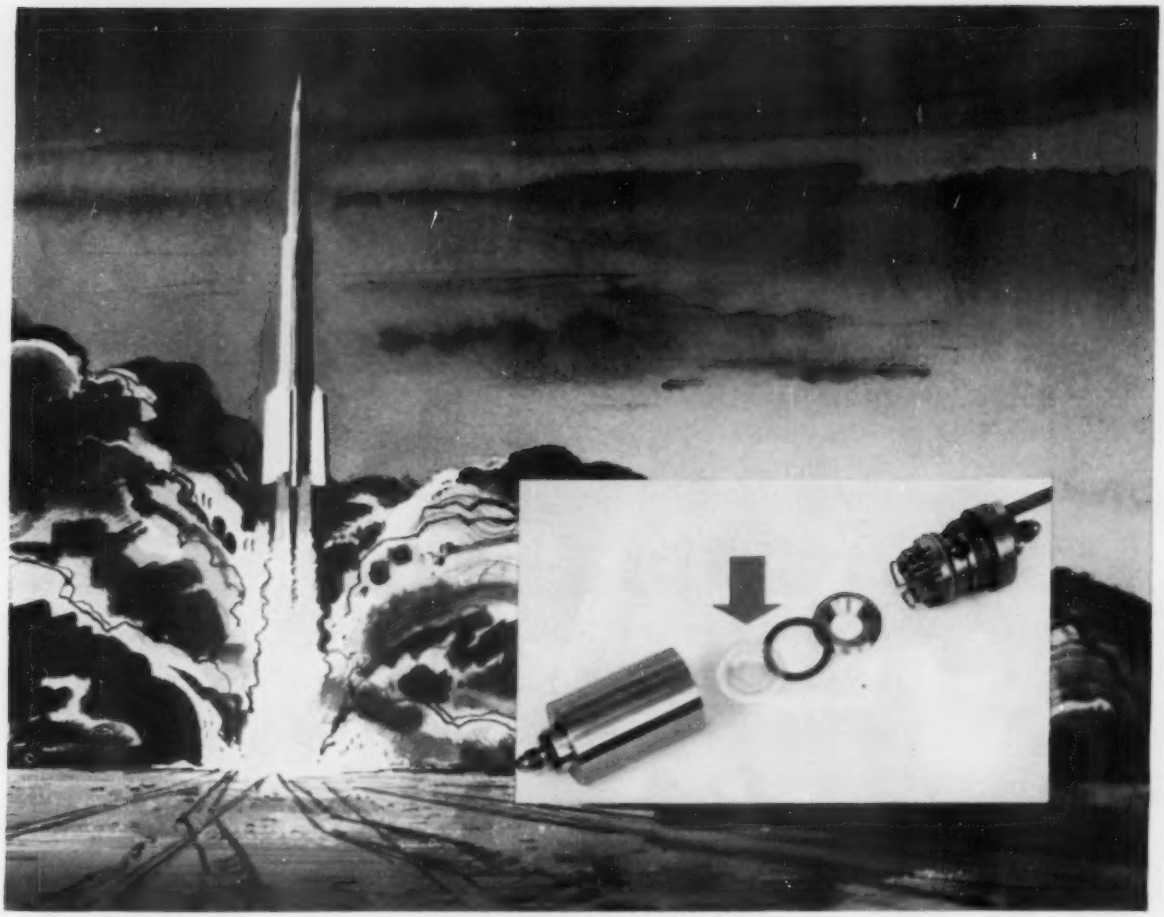

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KEL-F Brand Oils, Waxes and Greases, too, have remarkable properties. Their uses include: Compressor lubricants, damping fluids, hydraulic and pump fluids and liquid dielectrics.

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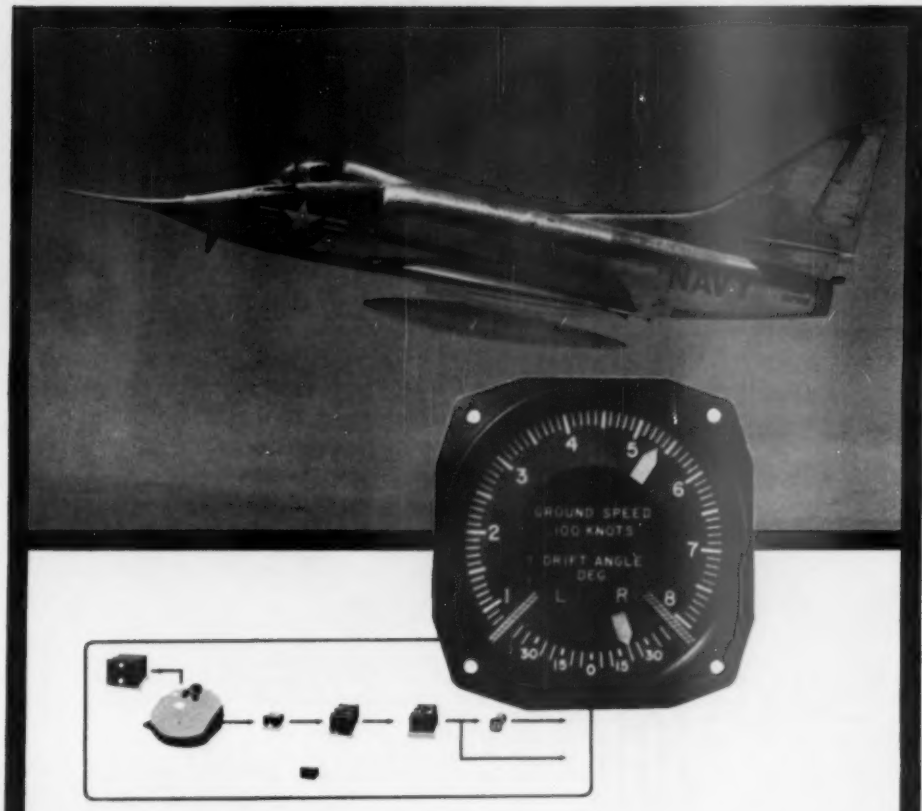

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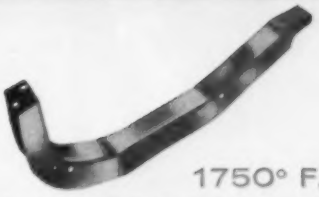
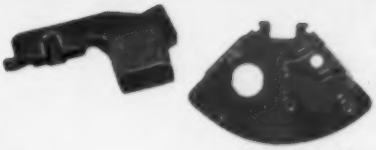


1750° F.

Metallized heat-reflective laminates—Improved metallizing techniques combine the reflectivity of thin, durable—603 gold or—101 aluminum coatings with high strength and thermal resistance of reinforced plastics. For prolonged heat exposure applications, blankets, compartment and valve protection, exhaust heat damping. Shown: typical compound contour part.

650° F.

Silicone laminates—Recent improvements in processing now allow the designer to take advantage of the inherent excellent strength retention under high heat and moisture. For airstream uses at missile speeds, nose and exit cones, fins, stabilizers, adapter and closure rings. Shown: missile tail cone.



600° F.

Phenolic laminates—High strength and good electrical properties at high temperatures characterize a fast increasing variety of Swedlow phenolic laminates. High dimensional stability and minimum thermal expansion make these laminates useful for nose cones, fins, stabilizers, adapter rings. Shown: molded switch cover and switch case.

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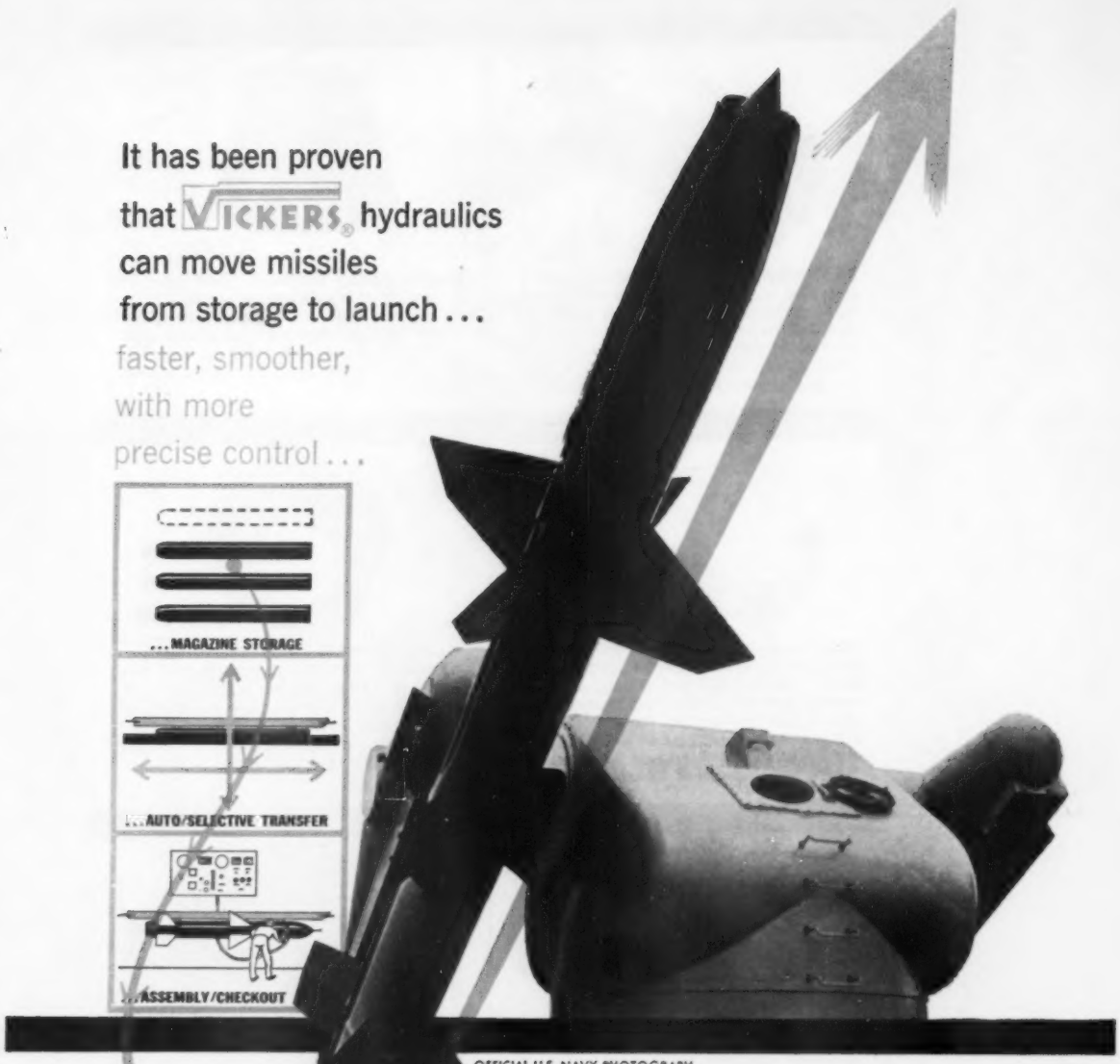

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October 31, 1960

Aviation Week and Space Technology

Vol. 73, No. 18
Member ABP and ABC

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▶ Demonstration model of United Aircraft Corp.'s ion engine could be flown in satellite in two years, company says.

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COVER: High-velocity plasma exhaust from United Aircraft Corp.'s oscillating-electron ion rocket engine (at right), operating on argon propellant, strikes water-cooled tantalum target at left. Engine, which is enclosed in space-simulating vacuum system, has produced up to .01 lb. thrust.

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EDITORIAL

Some Problems Ahead

The next President of the United States will inherit in a few weeks a heavy agenda of unsolved problems in the national defense area. Most of these are the result of technical timidity and chaotic management in the past few years, but some of them will be solely the product of the technical and political era we are now entering. Both types of problem will have to be tackled by the new chief executive and his cohorts with considerably more vigor, technical literacy and skill than has been demonstrated by their predecessors if this country is to maintain its position as a positive force in the decades ahead. For, given the political and technical ingredients now available to all of the major contenders in the international arena, we cannot maintain or improve our position automatically by rolling leisurely on our past momentum. Achieving this objective will require not only more effort but considerably better direction and management of this increased effort.

The failures of the past decade, and these bear both Democratic and Republican political labels, were not deficiencies in our technical skill, industrial capacity or military leadership. Indeed, wherever an executive or legislative green light has been flashed, the technical progress achieved in specific areas in an allotted time span has been phenomenal.

They have been the failure of our highest level leaders to recognize and understand the nature of the technological revolution that has so altered the world in the past decade and the failure to properly organize and direct our technical, industrial and military resources toward the national goals that this revolution made mandatory for survival in the future.

The problems facing the new President in the defense area fall into two broad categories: those immediate problems that have become acute through specific inadequacies during the past few years; and those long-term problems that require development of new national strategy consistent with the technical revolution and our political goals and require the fundamental reorganization of the management pattern of our military system and its relationship with the scientific and industrial complex on which it depends for this advanced technology.

In the first category, the most acute problem is undoubtedly that of adequately providing for a continuous airborne alert for a significant portion of Strategic Air Command's B-52 fleet. Some steps have been authorized in this direction, but their scale is so small as to be almost meaningless in creating a genuine airborne alert capability for the critical years when it will be needed most. This is an area where immediate improvement is possible through simple fiscal and executive action. Unfortunately, not all of the defense problems present such a clear-cut opportunity for swift and decisive action as does the full implementation of SAC's airborne alert capability.

Another immediate decision that must be made is the determination to proceed with the development of operational space systems in all of the areas where they have already demonstrated their technical feasibility, such as communications, weather, early warning and a variety of reconnaissance methods. While research and development in these areas has recently been accelerated after a nine month campaign of heavy pressure on the White House by the Congress, military, press and public, there still has been no decision to move into an operational system in any of these vital categories. No matter how swift and successful the research and development phase of these programs is—and the progress rate has been tremendous—the payoff in operational systems is being needlessly delayed by the lack of an executive decision to move into all of the other areas required to put into service and maintain an operational space system for any of these above named purposes. Here again is an area where a simple, clear-cut policy decision offers the prospect of substantial dividends in significant achievements within the most critical years ahead.

There are other areas where quick decisions are required to accelerate, expand and reorient programs already under way. The new President can hardly delay beyond Nov. 9 to begin preparing to exercise his first powers of decision in the new year.

But the most complex and really serious problems lie in the long-term approach to effective management of our defense resources and their continuous tailoring to an evolving pattern of modern strategy, rather than constricting their technology to the patterns of backward-looking military traditions. This country certainly has the scientific skills, the industrial capacity and military vision to lead any international technical race by a continuously significant margin. But no nation can afford to squander these resources indefinitely on a system that does not transform new technology into effective weapons within a sufficiently short time span.

We are not now getting $40 billion worth of effective defense for this annual expenditure in the field, and more money is certainly not a panacea for effective solution of the defense problem.

One of the biggest obstacles to effective management of the defense effort has been the rather naive conflict-of-interest laws, requiring top defense officials to divest themselves of any financial interest in a military contractor, that have effectively barred most men with experience and proven ability in the defense area from participating in the key levels of its management. These laws have resulted in a steady stream of unskilled amateurs being injected in short-term tenures at the highest management levels of the defense effort. It should be obvious by now that a two year leave of absence from a soap factory is not a satisfactory method of recruiting top level civilian defense managers.

—Robert Hotz

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Robert L. Smallman, vice president-marketing, Servo Corporation of America, Hicksville, N. Y.

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Charles H. Brunell, president, Century Electronics and Instruments, Inc., Tulsa, Okla., and Wallace G. Thomson, vice president-government services, Century Geophysical Corp., parent company of Century Electronics and Instruments.

Jules C. Laegeler, vice president-engineering, the Frank G. Hough Co., Libertyville, Ill. Also: **Keith W. Kampert**, chief engineer-product design; **Thorvald Granryd**, chief engineer-research and development.

Roy W. Pyburn, assistant to the president, Data-Control Systems, Inc., Danbury, Conn.

Harold R. Logan, formerly deputy comptroller for budget of the Department of Defense, now vice president-planning and programing for Grace Line, Inc., New York, N. Y. **John H. Fitch**, formerly Director of Budget (Air Force), will assume Mr. Logan's duties as acting deputy comptroller for budget.

Brig. Gen. M. D. Adams, deputy director of systems development, deputy chief of staff-development, Headquarters, USAF. Also: **Brig. Gen. T. C. Bedwell, Jr.**, commander, USAF Aerospace Medical Center, Air Training Command, Brooks AFB, Tex.

(*Continued on page 104*)

INDUSTRY OBSERVER

► North American Aviation is conducting a company-funded study of a solid propellant air-launched ballistic missile for the Mach 3 B-70 bomber. Effective adaptation of the Douglas Skybolt ALBM to the B-70 would require extensive redesign, close to development of a second generation weapon.

► **Chute recovery system projected for Air Force Ballistic Missile Division's advanced E-6 version of the Samos reconnaissance satellite capsule will have to incorporate guidance capability for controlled letdown to a prescribed recovery area. Avco already is working on one development, and Northrop's Radioplane Division also is proposing a chute recovery system.**

► Boeing will base its decision on whether to use ground-based command guidance or inertial guidance for its Dyna-Soar vehicle partly on results of a study by Arinc Research Corp. on the comparative reliability of the two guidance techniques.

► **Joint venture arrangement for proposals and for handling work in the missile and satellite ground support field are under discussion by International Telephone and Telegraph Corp. and Food Machinery Corp. This would combine ITT's avionic capability and Food Machinery's mechanical and hydraulic capabilities.**

► NASA has decided not to include a chimpanzee in the last Little Joe launch of a Mercury capsule. Chimpanzees currently are being trained at Air Force Missile Development Center, Holloman AFB, for launch over Atlantic Missile Range in Redstone-boosted Mercury capsule flights.

► **NASA's S-30 ionospheric direct measurement satellite is scheduled to be launched Nov. 3 from Cape Canaveral, Fla., with a Juno II vehicle. The 92.5 lb. payload was developed by Goddard Space Flight Center.**

► Bioscience officers will be assigned to USAF System Project Offices, such as B-70 and Dyna-Soar, under ARDC's revitalizing of its bioastronautics effort. Previously, SPOs have had the services of biomedical laboratories but have not had medical personnel assigned directly.

► **Intense Soviet drive for overseas aircraft sales was evident the past two weeks at the Tunisian International Fair, with the Russians scheduling the Mi-4 helicopter, Yak-18 sport aircraft and the agricultural version of the An-2 biplane for display.**

► NASA Lewis Research Center soon will begin a soft lunar landing research program which will include construction of wind tunnel models and test vehicles.

► **General Motors' new defense systems organization will concentrate at least initially on the submarine detection field. Company may spend as much as $10 million annually to develop a system capability, which was considered too costly for any of its existing divisions to provide out of individual division earnings.**

► Strategic Air Command 43rd Bomb Wing B-58 has flown faster than Mach 2 for a total of more than 78 min. in two segments of a refueled three hour test flight over the Gulf of Mexico. Longest previous flight above Mach 2 was 58.5 min. during a Seattle-Ft. Worth flight.

► **Three Kaman H-43B helicopters assigned to Warren AFB, Wyo. will remain there after Strategic Air Command completes a study of their potential use for transportation between ICBM missile sites. The H-43Bs were delivered to Warren directly from the production line.**

► Boeing B-52 fitted with dummy Douglas Skybolt ALBMs under its wings will begin a series of local flights from the company's Wichita Division early in December to check aircraft-missile compatibility.

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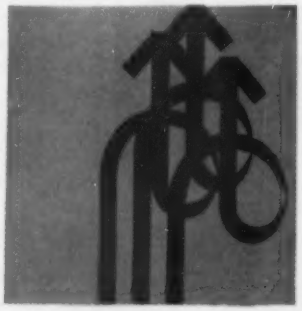

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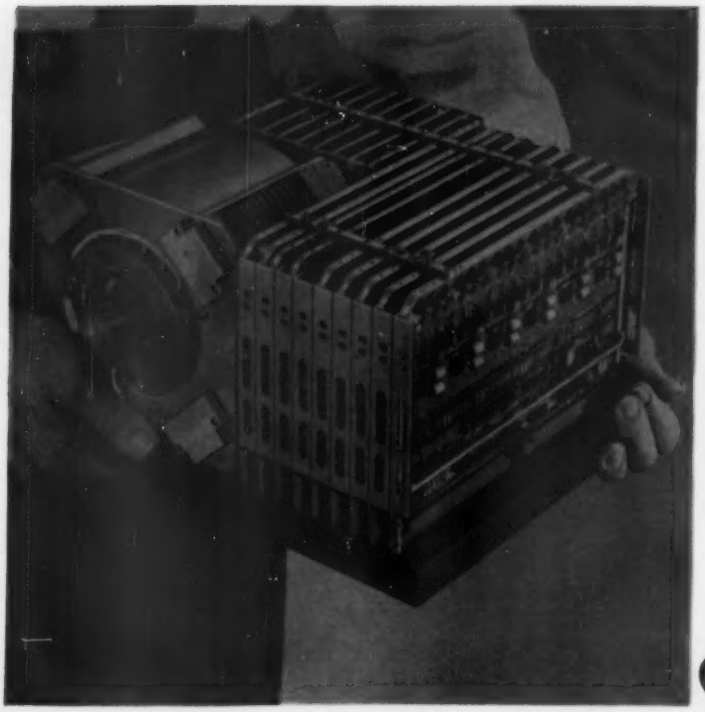


GPI LI-04

Washington Roundup

Prestige Debated

U. S. prestige became a major campaign debate last week. Democrats generally took the position that it is at an all-time low while Republicans maintained that it is at an all-time high.

Series of surveys made by and for the United States Information Agency became the crux of the argument. The White House has refused to make results of these surveys public. It insists that one—covering reaction in 10 European countries—is classified secret and is an internal, low-level staff paper. Sen. William J. Fulbright, chairman of the Senate Foreign Relations Committee, insists the survey was prepared for the National Security Council and is therefore very high-level.

Fulbright said the European survey, made late in August, showed that eight of the 10 countries polled thought Soviet Russia would be superior to the U. S. in military power in 1970. Other polls reportedly reflected the opinion that Russia already is ahead.

Democratic presidential candidate Sen. John F. Kennedy accused the Administration of keeping the surveys secret to protect Republican candidate Vice President Richard M. Nixon.

Nixon stuck to his position that prestige has never been higher, basing this mainly on recent favorable United Nations votes. He got strong support from President Eisenhower, who said that when "We hear some misguided people wail that the U. S. is stumbling into the status of a second-class power and that our prestige has slumped to an all-time low, we are simply listening to debasement of the truth."

The White House said the President spoke from his knowledge of all the facts not just from a position paper prepared for one agency.

Polaris in Scotland

Britain has agreed to let the U. S. station Polaris fleet ballistic missile submarines at Dunwoon, Scotland, and the British navy has hinted that it, too, would like to have Polaris subs—but it says the U. S. has not yet made such an offer.

Britain meanwhile is studying a U. S. plan to give NATO Polaris subs. With Britain and the U. S. now the only free world nuclear powers, but with France moving rapidly toward an independent nuclear status, the question of arming NATO with its own nuclear weapons still is far from settled.

Soviet Premier Nikita Khrushchev's claim that Russia already has nuclear-powered subs armed with rockets is certain to affect thinking on the Polaris situation.

U. S. and Britain have revised their 19-year-old agreement on stationing of USAF aircraft at British bases. Political demands that Britain have more knowledge of U. S. activities and more control over USAF flights from these bases resulted from the shooting down of a British-based RB-47 over the Barents Sea. Prime Minister Harold Macmillan said the new terms ensure that U. S. activities from these bases will be "fully known" to his government, but he left unanswered the question of whether Britain now has veto power over specific flights.

Federal Aviation Agency chief E. R. Quesada made a bid last week for the American League baseball franchise in Washington. He will leave FAA in January if he is successful in acquiring the new franchise, created to replace the Senators when they move to Minneapolis.

Aeroflot Competition

"Aeroflot is not a competitive threat now to U. S. flag carriers, but the Soviet airline will match U. S. service in four years if it continues to improve at the present rate. This is the impression Air Transport Assn. President Stuart G. Tipton carried away from his recent trip to Russia. He feels the pace of Aeroflot improvement would be faster if the airline joined the International Air Transport Assn.

Tipton feels Aeroflot has failed to perceive the public preference for turbojet transports and has made a big mistake in concentrating so heavily on turboprops.

American Rocket Society and American Astronautical Society are about to resume discussions of a possible merger after a hiatus of more than a year.

Capt. Allan F. Fleming will become the new director of Navy's Astronautics Division in December. Currently commanding the carrier Saratoga, Capt. Fleming will replace Capt. Richard L. Kibbe, who will become First Fleet chief of staff.

—Washington Staff

Space Technology

USAF Plans Radical New Space Plane

Studies costing $20 million sought in next budget; earth-to-orbit vehicle would need no large booster.

By Larry Booda

Washington—Air Force is requesting $20 million in its Fiscal 1962 budget for research and development on Space Plane, a radically different manned, winged vehicle that would fly both in the atmosphere—storing oxygen to burn in its engines—and into space as far as the moon.

Space Plane would be a 500,000-lb. follow-on vehicle to orbital versions of the much smaller Dyna-Soar boost glider. The new funds would cover studies designed to lead to flight tests in the 1966-1968 period.

Space Plane would be the first manned space vehicle that could propel itself from earth into orbit and return to earth under its own power, requiring no large rocket booster such as Mercury, Apollo and Dyna-Soar do.

Most unusual feature of this vehicle is that it would almost double its half-million pound takeoff weight as it flew through the upper atmosphere because it would collect oxygen for its engines as it flew.

Lt. Gen. Roscoe C. Wilson, deputy chief of staff for development, briefly mentioned USAF's interest in a Dyna-Soar follow-on in a recent speech before the Society of Automotive Engineers' Aeronautic Meeting and Air Force Office of Scientific Research Astronautics Symposium in Los Angeles (AW Oct. 24, p. 32). AVIATION WEEK has learned that his reference was to Space Plane and that it is one of four or five major space weapon systems for which USAF is seeking development funds.

The vehicle might be used for a variety of missions, including resupply of weapon systems now planned for development by that time.

Several Types of Engines

Takeoff of Space Plane would be accomplished by means of self-contained engines, possibly of the standard turbine type, plus jettisonable rocket boosters. Propulsion in the fringes of the atmosphere—285,000 to 380,000 ft.—could be by means of the turbine engines, fueled with hydrogen, or with hydrogen-fueled ramjets. Propulsion in space would be by means of a conventional rocket system, burning liquid hydrogen and the liquid oxygen collected during atmospheric flight.

Reason for the unique oxidizer-storing system is to enable man to travel further into space using a lighter-weight vehicle at takeoff and chemical propulsion systems that are believed to be within the current state of the art and can be available in the time period planned. Space Plane probably would be the last chemically powered spacecraft because it is believed that non-chemical systems in the nuclear and nuclear-electric fields will be sufficiently developed in the mid-1970's to power a follow-on craft.

Mission profile of the vehicle envisions the following sequence:

- **Normal aerodynamic takeoff** combined with rocket boost to furnish both vertical and forward thrust.
- **Rapid climb to upper limits** of aerodynamic lift.
- **Acceleration to orbital speed.**
- **Orbit for sufficient time** to fill tanks with liquid oxygen.
- **Proceed on space mission.**
- **Return to fringes of atmosphere** for gradual deceleration from re-entry speed of 35,000 fps. Aerodynamic lift on wings would be used to overcome centrifugal force and hold the craft in a circular flight path while drag gradually slows it.

The alternative to the last step would be another oxygen-gathering cycle if the hydrogen load had been only partially consumed. The vehicle could then perform another space mission.

- **Return to surface** for standard approach and landing.

Principle of the fuel system for the space portion of the flight depends on the chemical conditions surrounding burning of oxygen and hydrogen. Eight pounds of oxygen are required for every pound of hydrogen. This hydrogen-oxygen combination produces one of the most efficient rocket propulsion fuels, yielding high specific impulse.

Since the increase in gross weight after takeoff would be from 500,000 to 1,000,000 lb., the proportional amount of liquid hydrogen needed at takeoff would be 62,500 lb. However, an unspecified amount of liquid hydrogen would be required for operation with the oxygen extraction system. Estimates by engineers run between 10,000 and 25,000 lb. as the extra amount of hydrogen needed for the air-gathering and processing cycle.

Air Liquefying Cycle

Design of the vehicle would incorporate a large scoop whose open part would be pointed forward. Basic principle of the scoop would be to gather the very lightly associated molecules of oxygen and nitrogen, and, through a venturi or ram system, compress them to a normal gas fluid state. Vehicle speed during this collection cycle would be about Mach 18.

The compressed air would then pass over a heat exchanger whose coolant is liquid hydrogen. Temperature of the exchanger would be −252.7C or colder, which would liquefy the air. From this exchanger the liquefied air would go to a storage tank. From here it would pass through a flip-flop valve to another tank where fractional distillation would take place. Nitrogen, with a boiling point of −195.8C, would be separated from oxygen, which has a boiling point of 183.0C. From the distillation chamber the liquid oxygen would go to a storage chamber where it would be kept until needed for propulsion.

Although the principle outlined above is not new and is possible in accordance with basic rules of physics, major heat transfer problems face the designers because of the difficult task of extracting heat from the gasses and liquefying them in flight.

In Space Plane, a large portion of the airframe interior would be taken up with heat exchangers, and some engineers believe the vehicle will be essentially a flying radiator with a large open mouth.

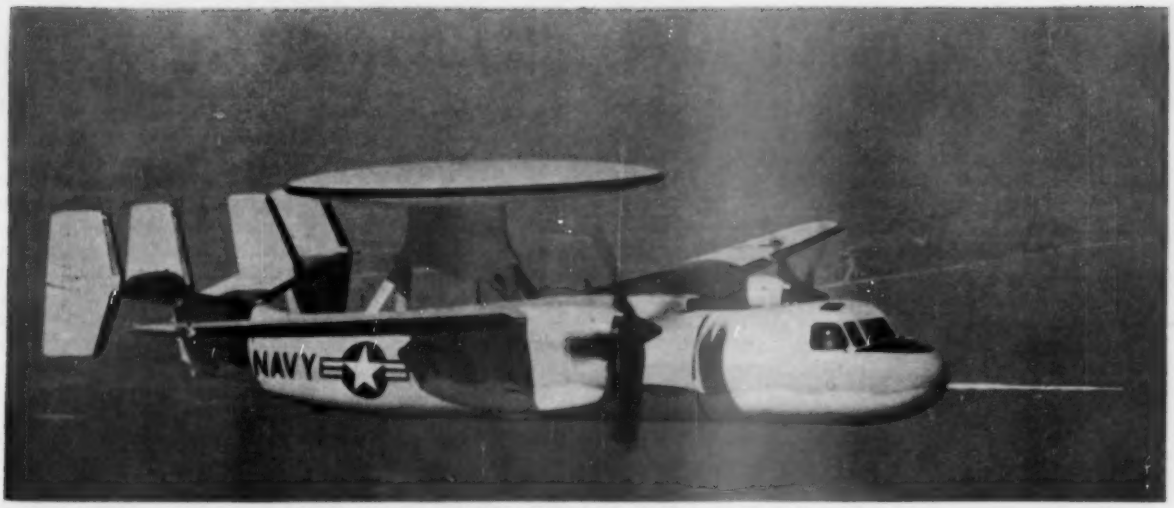
Unless there is a major advance in metallurgy, the vehicle will be constructed of molybdenum, as Dyna-Soar will be (AW Sept. 26, p. 33).

Air Force planners emphasize that the concept will be subject to many changes in the study phase and the research and development phases, but the system is based on studies already completed, such as Northrop's Profac, a vehicle using an oxygen recovery system similar to the above.

Crash Kills Nedelin

Moscow—Marshal Mitrofan Nedelin, supreme commander of Soviet Russia's rocket command and a deputy defense minister, was killed on duty Oct. 24 in an air crash, the government news agency Tass said. No details were given.

Soviet Premier Nikita Khrushchev credited Marshal Nedelin's forces with shooting down the Lockheed U-2 reconnaissance aircraft last May 1. Marshal Kirill Moskalenko has been named to succeed Nedelin in both positions.



Grumman W2F-1 Makes First Flight

First flight of the prototype Grumman W2F-1 Hawkeye, a Navy turboprop early warning aircraft, was made last week. The aircraft was later demonstrated at a rollout ceremony at the company's Peconic River facility. The W2F is a twin-engine, high-wing aircraft designed for radar detection and control of intercepts over Navy task forces. Powerplants for the aircraft, two Allison T56-A8 turboprop engines rated at 4,050 eshp., are said to provide greater speed, endurance and altitude capabilities than the WF-2 Tracer (AW Jan. 11, p. 85), now performing airborne early warning missions in the fleet. The Hawkeye avionic system, developed by General Electric's Light Military Electronics Department, is called ATDS (airborne tactical data system). This radar/computer/data link system may either solve intercept problems independently or feed information to a Naval Tactical Data System aboard a flagship. Normally the aircraft will circle the fleet in teams to provide maximum radar coverage. Carrying a crew of five, the W2F will be one of the Navy's largest carrier aircraft. It has a wingspan of 80 ft. and an over-all length of 56 ft.

U.S. Supersonic Transport Project With Government Funds Expected

Washington—Development of a supersonic transport through design study contracts let to manufacturers by the Federal Aviation Agency, with National Space and Aeronautics Administration continuing its research and acting as technical monitor of the project, now appears likely.

The principle of government support of the development of a supersonic transport has been strongly endorsed in a survey undertaken for the FAA by United Research, Inc., which found that the airframe industry will not embark on a supersonic project without assistance from the government.

Meanwhile, the British Ministry of Aviation has granted a contract to British Aircraft Corp. to begin design studies on a supersonic transport although the government has urged that possibilities of cooperating with the U. S. on the program continue to be explored. Sud Aviation and Avions Dassault have combined to develop a supersonic transport in France (AW May 2, p. 41) and Soviet Russia also is known to be developing such an aircraft.

Under the present plan, study contracts will be let to several manufacturers and the best two proposals will be selected to enter the detail design phase of the project. Since FAA does not wish to expand its present technical staff for the program, technical details will be handled by NASA.

The United Research report found that the market for supersonic transport aircraft is not sufficiently large to support the construction of such an airplane by more than one manufacturer in the free world. It added that as long as no manufacturer can ensure himself against the competition of another, the "foreseeable risks are substantial."

R&D Expense

It noted that the research and development expense alone in completing the program by 1970 will amount to as much as $1 billion, even with an active B-70 program in process. The report stressed that technical and financial risks will be greater by a wide margin than any previous known commercial risk.

The report found that the airline industry "could and would" buy economic supersonic transports if they were available in 1970. This conclusion was based on the fact that substantial traffic growth can be expected during the next decade and that the historical industry trend toward a steady replacement or older equipment with newer and faster aircraft points to a requirement for a long-haul supersonic transport from commercial use by 1970.

The report concluded that major U. S. carriers will have about $1 billion in cash on hand by 1970 which, coupled with accruals of some $400 million per year from depreciation, should provide adequate funds to support the purchase of supersonic aircraft.

The report estimated that, if the planes were available in 1970, U. S. carriers would be in the market for 75 in 1970 and 116 by 1975. Cost of each aircraft to the airlines is estimated at $25 million including spares.

The report warned, however, that although the commercial market for a supersonic transport may range as high as $4 billion, the market "is far from assured." It said sales would depend upon manufacturers' ability to produce a plane that can be operated at total costs competitive with those of subsonic jet aircraft. It also said the market is dependent upon the capability of the airlines to integrate supersonic operations into existing facilities and procedures without incurring economic penalties.

The report concluded that there is no reasonable prospect for a timely commercial program for the development of a supersonic aircraft without government support. It warned that no manufacturer is likely to undertake the financial risks involved without some assurance that research and development costs will be recovered.

Ion Engine Flight Tests Planned for 1963

By Edward H. Kolcum

Washington—Greatest possible variety of electric space propulsion proposals from industry is being encouraged by the National Aeronautics and Space Administration before it decides next year which four ion engines will be flown in ballistic flight tests of the concept starting in early 1963.

Four tests of first-generation, battery-powered ion engines in ballistic flights are planned as a prelude to a 1965 flight with a SNAP 8 reactor system powering both ion and arc jet electric engines in a single test.

Hughes Aircraft Co. currently has a development contract for a laboratory ion engine, and General Electric, Avco and Plasmadyne have contracts for experimental arc jet engines. NASA wants to award further study contracts in the field, and it will decide next year which four ion engines will make the first test flights after studying current work, results of any future study contracts and industry proposals.

Centaur-boosted SNAP 8 system will test a 0.1-lb. thrust ion engine and a 0.5-lb. thrust arc jet engine. The ion engine could be either a single-chamber model or a cluster of 10 .01-lb. systems.

Primary objective of the first tests, to be conducted over a 12-month period, will be to assess methods of beam neutralization, considered the most severe technical design problem in ion propulsion. Secondary objective is to establish engine performance parameters by comparing flight and laboratory data. The ion engine must exhaust a neutral beam, since particles in a charged beam would be attracted to the engine structure and form a cloud at the exit, resulting in no thrust.

NASA feels that a real test of beam neutralization can only be made in space, even though ion engines have been run for long periods in vacuum tanks. Vacuum chamber walls and residual gases in ground tests are unnatural influences and therefore do not provide a true environment for studying neutralization methods.

NASA says it will welcome any electric propulsion system proposals from industry. Industry contact for proposals is the space propulsion programs office, headed by Dr. Harry Harrison. Program assistants are Ira R. Schwartz and Capt. Richard J. Hayes, assigned to NASA from the Air Force.

Government awareness of expanding industrial interest in electric propulsion was reflected in the establishment last month of a NASA development committee to plan and manage development and test of electric propulsion systems, and to consider funding industry programs which show merit. Operating under this committee, which Harrison heads, is a technical working group under Dr. Ernst Stuhlinger, director of the Research Projects Division at NASA's Marshall Space Flight Center.

Harrison's committee consists of program managers in NASA's Launch Vehicles and Advanced Research offices, so that the agency's considerable electric propulsion research, industry research and development, and scheduling of launches will be blended into an orderly program.

NASA's immediate electric propulsion effort is centered around basic research in ion propulsion at Lewis Research Center, basic studies in magnetohydrodynamics (MHD) at Langley Research Center, the four engine development contracts with industry and a number of relatively small contracts to support applied research.

The agency is increasing this effort, mainly through the policy of being prepared to consider, and fund, attractive industry proposals. Harrison, Schwartz and Hayes are compiling a broad-based list of unsolved development problems.

Most promising electric propulsion systems for use in the near future are electrothermal, which use the arc heated principle; electrostatic, or ion beam; and electrodynamic, also called magnetohydrodynamic.

The four development contracts now out are for three experimental arc jet engines and one laboratory ion engine. NASA plans to request proposals for an MHD engine. NASA also plans to fund several far-ranging studies to identify space missions for first-generation ion and arc jet engines, specifically where these engines are potentially superior to chemically-fueled upper stages. Studies are expected to result in analytical comparisons of existing and projected Saturn upper stages with the 0.1-lb. thrust ion, and 0.5-lb. thrust arc jet engines.

Ultimate objective for NASA's first generation flyable ion engine—which will use the 30 kw. SNAP 8 electrical power—is to develop .1-lb. thrust over a one-year operating lifetime with a specific impulse of 4,000 to 6,000 sec.

Hughes Aircraft Co. is constructing an 0.01-lb. experimental ion engine under a $490,000 one-year contract which will expire in September, 1961. NASA will wait until this engine is laboratory tested before deciding whether to have Hughes develop it further as a single-chamber 0.1-lb. thrust system, cluster 10 0.01-lb. engines to

Swiss Favor Mirage III, Saab Draken

Bern—Lockheed's F-104G and Grumman's F11F-1F, the two remaining U.S. entrants in the aging Swiss air force competition for a new fighter aircraft, were tentatively ruled out last week, apparently leaving the field open to France's Dassault Mirage III and Sweden's Saab J35 Draken.

Cost was given as the primary reason behind the decision to eliminate the F-104 and F11F-1F from consideration, but some Americans, looking at the tortuous past of the competition which is now more than two years old, expressed some hope that one or both might again be reinstated.

Swiss military officials apparently favor the Mirage III as the aircraft that can most successfully operate from the air force's short-runway, hard-to-get-to alpine fields and carry out the three-fold mission imposed upon it—close support, fighter bomber and interceptor.

Air force pilots have been impressed by the Mirage's handling characteristics and high altitude performance, and Swiss officials are insisting upon an advanced all-weather fire control system, which Dassault says it can accommodate by extending the aircraft's fuselage.

Mirage III proposals, however, already have been shelved on at least two occasions in the past by the Swiss political administration which balks at the thought of any large order from a country belonging to the European Inner Six economic community, as France does, when a similar product can be purchased from the rival Outer Seven, of which Switzerland is a member. Since Sweden also is a member of the Outer Seven, this factor could serve to give the Draken one of its biggest boosts.

Deadline for a final decision is being shifted to the end of the year at least and, in an effort to overcome political roadblocks, the Swiss may invite the Mirage III and Draken to demonstrate their capabilities in operating from the air force's cramped mountain fields.

In placing any new order, the Swiss hope to obtain license rights that would permit Switzerland's own industry to build most of the aircraft involved, including engines.

The Swiss air force at present is composed of 500 obsolescing combat aircraft—100 Hawker Hunters, 250 de Havilland Venoms and 150 de Havilland Vampires.

provide this thrust, or go to other firms entirely for flight hardware.

It is expected that at least one flight test will be made of an engine developed at Lewis Research Center.

NASA's ion engine will use the contact method of ionizing cesium fuel to produce a particle stream. Air Force is funding a second ion-producing method, called bombardment (see story, p. 73).

Contact method uses the principle of heating liquid cesium metal until it becomes gas and impinges on the surface of a porous tungsten electrode plate, separating negative particles from cesium atoms. Positive ion stream is then focused and brought to desired velocity by a system of accelerator/decelerator electrodes.

The stream is neutralized by injecting electrons at low velocity at the exit. The critical design problem in the electron injection is that the negative particles must be prevented from drifting backward into the chamber or a thrust fluctuation will result from non-constant exhaust velocity.

While beam neutralization in the space environment is the major problem in ion engines, NASA feels development of this engine also depends on fixing the spacing between focusing, accelerating and decelerating electrodes, and on determining optimum particle exit velocity.

General Electric Flight Propulsion Laboratory and Avco Research and Advanced Development Division, each with $250,000 contracts, are developing 0.5-lb. thrust arc jet engines in competing projects for NASA. Plasmadyne Corp. has a $200,000 contract to build an experimental 1-kw. arc jet engine, to be powered by the Sunflower solar collector-converter system. First flight test of a 0.5-lb. thrust engine will be with the 1965 SNAP 8 launch. Flight of a 1-kw. engine is under study.

Arc jet system, formerly called plasma engine, uses a cold gas such as hydrogen or helium as fuel. The gas is heated to a high temperature, passes through an electric arc and is expanded through a nozzle to produce kinetic energy. Specific impulse is 750 to 1,500 sec.

Specific research problems in this system are in engine start, energy losses, cooling, propellant storage, feeding and basic engine configuration.

Contracts to solve these problems are now under consideration by NASA, which is interested in studies of:

- **Engine losses** from fuel ionization, or frozen flow, and from heating and electrode design.
- **Cooling techniques,** including radiation, transpiration and convection.
- **Starting methods,** using energy discharge, bridge wire, movable electrodes or radioactivity.
- **Propellants,** including argon, ammonia, water and hydrides.

If fuel can be recovered from its ionized state, the arc jet engine has the potential of increasing efficiency from 20 to 60%.

Studies also are planned to determine possible use of heavy particles for fuel, since they provide a higher thrust than light ions if both are accelerated at the same velocity. Among potential sources are human waste and planetary dust.

NASA plans an 18-month feasibility study in the MHD propulsion field, including assessment of continuous, pulsed and induction means of accelerating exhaust. Current idea is to select one or two contractors who will explore the entire electrodynamic propulsion potential.

NASA's Voyager Venus Probe To Make First Flight in 1965

Pasadena, Calif.—National Aeronautics and Space Administration's Voyager space vehicle will use Saturn C-1 and C-2 boosters and will start developmental flights to Venus in 1965, Dr. William J. Pickering and staff members from California Institute of Technology's Jet Propulsion Laboratory said in a meeting with industry officials here last week.

The Saturn C-2 will give Voyager enough additional flexibility to permit flights outside of the plane of the earth's orbit in 1968 and fly-by missions to Mercury or Jupiter by 1970.

Four other NASA space projects being developed are:

- **Mariner.** It will precede Voyager and be a basis for its development. Centaur-boosted Mariner will conduct its first mission, a Venus fly-by, in 1962. The second Mariner mission scheduled is a deep space probe later in 1962 with a nearly identical spacecraft and a similar trajectory to gather additional engineering data and knowledge of interplanetary space. The same Mariner configuration with some refinements and instrument changes will be used for Venus opportunities in 1964 and perhaps 1965. First launch of a Mariner vehicle to Mars is scheduled in 1963. It will be a development mission and the vehicle will be a prototype of one to be used for a Mars mission in 1964. The trajectory will be chosen as the best test of the spacecraft and will involve an earth-return orbit. The first Voyager will be a Saturn-boosted extension of the Mariner system with the additional weight capability used mainly for retropropulsion and terminal guidance.
- **Prospector.** This is a study phase development for a Saturn-boosted vehicle capable of placing a wheeled or tracked mobile probe on the surface of the moon or returning samples of lunar material to the earth. Technical briefing, proposals and design competition for Prospector spacecraft will begin in 1961. Full-scale development will begin in 1962. First launch must await NASA Saturn booster system.
- **Surveyor.** This project, also in the study phase, is aimed at a controlled or soft landing on the moon. Surveyor will use a Centaur launching vehicle. Its spacecraft will weigh about a ton, including guidance and retrorockets, and it should be able to soft-land about 100 lb. of instruments on the moon. Four companies now have NASA contracts for design studies on Surveyor. They are Hughes Aircraft, McDonnell Aircraft, North American Aviation, and Space Technology Laboratories.
- **Ranger.** In this program five flights of a JPL-designed spacecraft with Atlas-Agena B launch systems will be used to rough-land (200-300 mph. impacts) instrument packages weighing up to 50 lb. on the moon. Propulsion up to the point of injection is the responsibility of the NASA Marshall Space Flight Center.

Private Industry

Dr. Pickering told 600 industrialists attending the meeting that about 65% of the $50 million that JPL will spend for NASA on its lunar and planetary program in this fiscal year will go to private industry. Dr. Pickering predicted the portion would rise next year.

Dr. Albert R. Hibbs, chief, the division of the space sciences, outlined the scientific objectives of the lunar and planetary programs.

He said:

"We hope that an active radar can be included in the Venus orbiter for mapping the surface since, as far as we can tell, the Venusian cloud cover is opaque to visual systems.

"A Mars orbiter will place more emphasis on surface photography. The exact portion of the spectrum to be covered in this photographic mission will depend on results obtained by spectrophotometers carried aboard earlier Mars near misses.

". . . It is clear that a landing spacecraft for the Martian surface must be employed. Such a spacecraft would carry several pieces of equipment to assist in this biological exploration program. It would probably have TV reading microscopes working in the ultraviolet and near ultraviolet region, as well as systems for culturing microorganisms and measuring the changes in the culture medium."

Nixon Claims U.S. Dominates Space Race

Washington—U. S. has surpassed Russia in all aspects of the space race except rocket thrust and will soon move ahead in that area despite failures of the Truman Administration, Vice-President Richard M. Nixon claimed last week.

The Republican presidential candidate's prediction was issued in one of his series of White Papers on major campaign issues, a document which strongly emphasized the importance of being first in space exploration, praised the Eisenhower Administration's progress in this area, and blamed the policies of the Truman Administration for the slow U. S. start in space technology.

"Sen. Kennedy [the Democratic presidential candidate] attempts to hitch his political wagon to the Soviet Sputnik, charging that the Eisenhower Administration is allowing the Soviets to outdistance us in the exploration of space," he said. "It is irresponsibility of the worst sort for an American presidential candidate to obscure the truth about America's magnificent achievements in space in an attempt to win votes.

"We entered the space competition some paces behind," he charged. "We paid a penalty because the Truman Administration discarded and ignored the implications of the long-range rocket. We were slow because that Administration in the years between 1945 and 1950 relied entirely on our lead in nuclear weapons and strategic bombers.

"Not until President Eisenhower took office in 1953 did the United States begin serious work on the intercontinental ballistic missile," the Republican candidate said. "Because those responsible for our security before him did not feel the need for long-range missiles—the U. S. made no effort to match the post World War II missile programs of the Soviets, which they in a large measure seized as a prize of war from the Germans in the year just preceding the Korean war—the year the Soviets successfully exploded their first A-bomb.

Nixon charged that the Truman Administration "eliminated the long-range missile development entirely," and that among the projects "wiped out was one which might have put the first U. S. satellite in orbit by 1952, five years before Sputnik."

Nixon said the U. S. must lead in the exploration of space because discovery is one of the tests of the vitality of a people. "We can no more leave this task to George—or Ivan—and still maintain our world leadership than England could have left the new world entirely to Spain and still have become the first power of the world during the two centuries that ushered in the modern era."

The Eisenhower Administration has "just about closed an inherited space gap," Nixon claimed. "We have been hard at work on the related problem—the so-called missile gap—likewise inherited—and we have achieved great success.

"With expenditures of more than a billion a year, utilizing the great resourcefulness of the giant industrial complex of America as well as that of the federal government," Nixon said, "we have surpassed the Soviet lead in the space competition in all respects but that of rocket thrust where the failures of the last Administration handed the Soviets a several-year lead; and even that lead is soon to be surpassed."

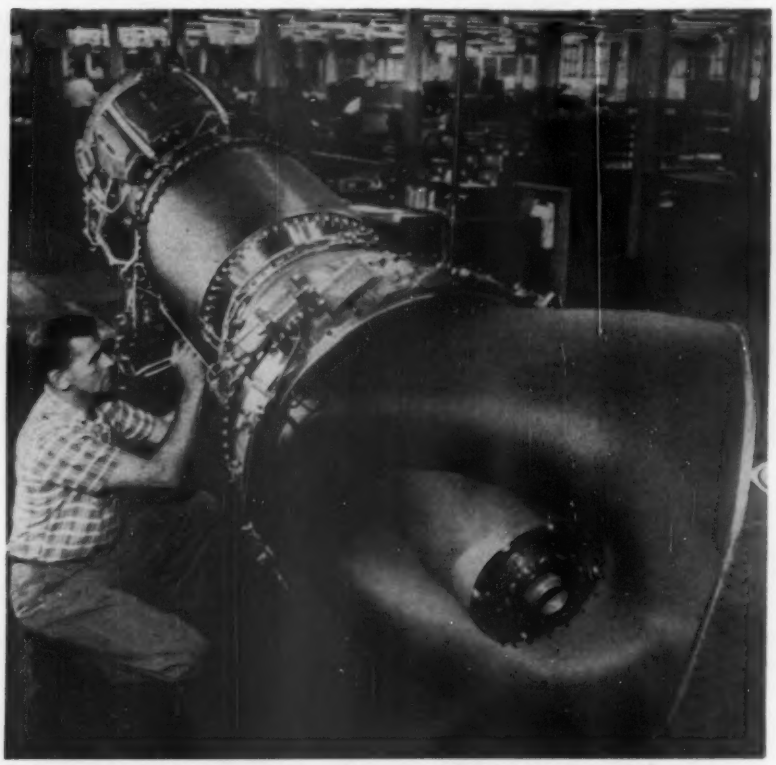
In the fourth television debate between the candidates the previous week, Nixon had ignored the thrust problem and had been more positive. ". . . We are first in the world in space, as I have indicated," he said. "We are first in science."

The Vice President said that to date the U. S. has launched 28 space satellites and space probes successfully to Russia's eight, and the U. S. shots, because of the character and value of the accomplishment, are of greater importance than the "superiority of sheer numbers."

While the next President is still in office, Nixon said, the first American astronaut "will almost surely complete true space flight," and it is also possible that the next President will receive at the White House the first American astronaut to return from circumlunar flights around the moon.

He said these events are scheduled in the national space program:

• **"We are proceeding** at top priority in the development of space rockets of lifting power in excess of any the Soviets are developing, according to information that I deem to be reliable. With our one and one-half million pound thrust Saturn vehicle we will take the lead in chemically powered space rockets.



Pratt & Whitney Develops JTFD-12 for Skycrane

New Pratt & Whitney JTFD-12 gas turbine engine features free turbine drive and will be installed in the Sikorsky twin-turbine S-64 Skycrane helicopter, at a rating of 4,050 shp.; industrial version, the FT-12, will be rated at 3,000 shp. maximum. Engine is outgrowth of the JT-12 turbine (Lockheed JetStar and drone powerplant). Blades in exhaust are guide vanes and free turbine is behind the exhaust. Shaft from the free turbine extends out to a connection for the engine's gear box.

• **"During the term** of office of the next President we will get the first nuclear-fueled engine capable of deep penetration into space.

• **"In the period** of 1966 to 1967 we will launch and operate a manned, permanent space station, orbiting at somewhere between 300 and 1,000 mi. from the earth, to which our astronauts will go and come and stage flights farther into space.

• **"We will launch** in the period from 1966 to 1968, manned circumlunar flights.

• **"By the early 1970s** we will launch manned space ships to land and return from the moon.

"Of course," he warned, "we cannot always lead all nations in all steps on the way into space, for each nation will pursue different programs with different emphasis. But this I pledge: If the responsibility becomes mine on Jan. 21, America will be second to none in the long stride into space."

The Republican candidate said it should be understood that this effort will be expensive, but he believed that every dollar that could be spent constructively and responsibly should be invested in the effort to quicken the exploration into the world of interplanetary space.

Convair, GE, Martin Win Apollo Contracts

Washington—Contracts to study feasibility of the multi-man Project Apollo spacecraft will be awarded to Convair Division of General Dynamics Corp., General Electric Missile and Space Vehicle Department, and Martin Co. Baltimore Division.

National Aeronautics and Space Administration is negotiating individual $250,000 fixed fee contracts with the three companies, and they will be awarded Nov. 14. The six-month studies are designed to provide a variety of views in defining a flexible spacecraft system for earth orbiting and circumlunar missions; time, cost and facilities required to implement the program; identification of existing technical unknowns which could block the program (AW Aug. 29, p. 26), and a cost analysis.

Convair, GE and Martin were selected to conduct the studies from among 14 firms submitting bids.

Although NASA did not specify identification of associates in the feasibility study, two successful bidders have chosen several partners, and undoubtedly all three will add a number of subcontractors as the studies develop.

Bell Aerosystems Division will join GE for work in the areas of high temperature structures, propulsion, energy management and reaction controls.

Convair team members selected to date are Avco Research and Advanced Development Division and Lovelace Foundation for Medical Education and Research.

Large number of potential additional associates is apparent from the high interest in the Apollo industry briefing Sept. 12, attended by representatives of 88 industry and research organizations.

Cessna Unveils 1961 Line

Wichita, Kan.—Major changes are evident in Cessna Aircraft Co.'s 1961 line of business aircraft, being unveiled here this week at the company's annual distributor and dealers meeting, which runs through Nov. 2.

Six new models, including the four-place Skyhook helicopter, are being shown for the first time, including a utility airplane, aimed at bridging the gap in the size class between the Canadian de Havilland Beaver and Cessna's familiar 180.

Named the Skywagon, the new Model 185 utility airplane is powered by a Continental IO-470-F 260-hp. fuel injection engine similar to that in the Model 210 and 310 airplanes. The new airplane, Cessna says, was designed in response to expanded mission and performance requirements, particularly in regards to heavier payloads than are possible in the 180.

Of configuration similar to the Model 180, including tailwheel-type landing gear, the Skywagon is designed to carry six adults plus 270 lb. of baggage and full fuel (65 gal. standard) at speeds up to 172 mph. Gross weight is 3,200 lb., and empty weight is 1,520 lb. At 164 mph. cruise speed the Skywagon will have an endurance of 4.7 hr. Rate of climb is stated to be 1,000 fpm. Model 185 will be priced at $18,950 for the standard equipped airplane, flyaway factory.

Revised lines on the nose, wingtip tanks, plus additional cabin windows mark the 1961 Cessna Model 310F five-passenger light twin. Nose cap of the airplane is more pointed than on earlier models, the trailing edge tips of the wing tanks have a rakish new look and the third added window on each side of the fuselage provides increased visibility for rear passengers. The 310F, powered by 260-hp. Continental IO-470-D engines, is equipped with new Scintilla retard-type magnetos for easier and faster starts. Two magneto switches, the starter switch and optional oil dilution switch are incorporated in one unit. System enables a more convenient tachometer pickup source and elimination of the tachometer generator used on earlier-type magnetos. The 310F will sell for $62,500 in the standard version, at the factory.

Improved Model 172, featuring a new fuselage, will be available in two versions, the standard 172 and the de luxe, completely equipped companion Skyhawk. Landing gear on these airplanes has been shortened three inches to provide easier ground handling. Powered by a 145-hp. Continental O-300-D, the 172 and Skyhawk will sell for $9,795 and $11,475 respectively, Wichita.

Landing gear relocated two inches aft is one of the prime features on the two-place Model 150 for 1961, the aim being to shift the center of gravity forward and improve ground handling. Powered by a Continental O-200-A of 100 hp., the new 150 will sell for $7,495 in the standard version, $8,400 for the trainer and $8,995 for the de luxe intercity commuter model.

Cessna plans to split unveiling of its complete model line this year. Being shown here are the Model 185, Model 310F, 172 and Skyhawk, the 150 and the Skyhook helicopter (AW Oct. 17, p. 131). Details of the other airplanes for 1961, including the Model 175 and Skylark, Model 150 and 180 will be released at simultaneous nationwide dealer showings scheduled for Dec. 2.

GE Strike Settled With 3-Year Contract

Washington — Three-week strike against General Electric ended last week when the International Union of Electrical Workers (AFL-CIO) accepted a three-year contract with essentially the same terms the company offered before the strike (AW Oct. 24, p. 33).

The union also reached agreement in substance with Westinghouse Electric on a three-year contract, ending threat of a strike against another major electrical equipment producer.

Under terms of the GE contract, IUE members will get an immediate 3% wage increase with an option, which union must select within 30 days, for either another 4% increase in 18 months or a wage reopening clause at the end of 18 months. If IUE accepts the former, individual locals will also have the opportunity to vote on a local option alternate arrangement under which they would receive a 3% increase in 18 months, instead of 4%, but would get a more liberal vacation and holiday plan.

Westinghouse agreement, similar to the one with GE, provides increase of 4 to 10 cents per hour immediately, and a similar raise in 18 months, with more liberal layoff, retirement and vacation plan. Both companies dropped former cost-of-living escalator clauses, a bone of contention with the IUE.

AT&T Plans Satellite Launch in One Year

By Philip J. Klass

Washington—American Telephone & Telegraph Co. has sharply accelerated its commercial communications satellite program and now expects to have an experimental satellite in orbit within a year. The satellite will provide one-way television or voice/data channels between the U. S. and Western Europe.

The company has asked the Federal Communications Commission to allocate two 100 mc. bands for its transatlantic communications satellite tests —6,425-6,525 mc. and 6,775-6,875 mc.

The AT&T action follows closely an FCC decision denying the company's petition that it reconsider previous frequency allocations above 890 mc. for private microwave systems. AT&T, which earlier had opposed the 890 mc. microwave decision on commercial grounds, warned FCC in July that failure to reopen the case could result in serious interference problems for communications satellites (AW July 18, p. 37).

AT&T Announcement

The AT&T announcement of its new satellite plans also followed a recent statement by National Aeronautics and Space Administration chief Keith Glennan that the agency would launch commercial satellites at cost (AW Oct. 17, p. 26).

Company's "within one year" timetable for placing its first experimental communications satellite in a 2,200 mi. orbit represents a sharp acceleration of the AT&T program.

Three months ago, when AT&T filed a 125-page petition with FCC urging it to reopen the above-890-mc. case because of communications satellite frequency needs, the company went into considerable detail on all aspects of its program, except a timetable—not even a tentative timetable was given. In response to an AVIATION WEEK query, one AT&T scientist indicated that the first experimental satellite was expected to be ready for launching "in a couple years."

Observers see several possible explanations for the faster tempo of the AT&T program. One is company concern lest pressures develop for the government to move into the commercial communications satellite field to accelerate the program and beat the USSR to the punch (AW Aug. 8, p. 31). Announcing the latest plans, AT&T Vice President Henry T. Killingsworth, in charge of the company's Long Lines Department, said:

"We believe that the commercial application of satellite communications is a job for private enterprise. This new project is still another indication of our readiness to take on that job and pay our own way."

Another motivating factor could be the growing number of avionics companies which have launched commercial communications satellite study and/or development programs. List includes Bendix, General Electric, Hughes Aircraft, International Telephone & Telegraph Co., Radio Corp. of America and Space Electronics Corp.

AT&T Specifications

The experimental satellite which AT&T will construct is expected to measure about 50 in. in diameter and weigh about 175 lb. It will be powered by solar cells. Satellite payload is expected to be completely transistorized except for traveling wave tubes used in the transmitter. Satellite transmitter output will be one or two watts. Two slotted antennas around the satellite waist will be used for transmitter and receiver.

For initial tests, the U. S. ground station will be located at the Bell Telephone Laboratories facility in Holmdel, N. J. Other terminal for the transatlantic tests will be located in Britain, or possibly on the continent in Western Europe. Station at Holmdel will use a 1 kw. transmitter.

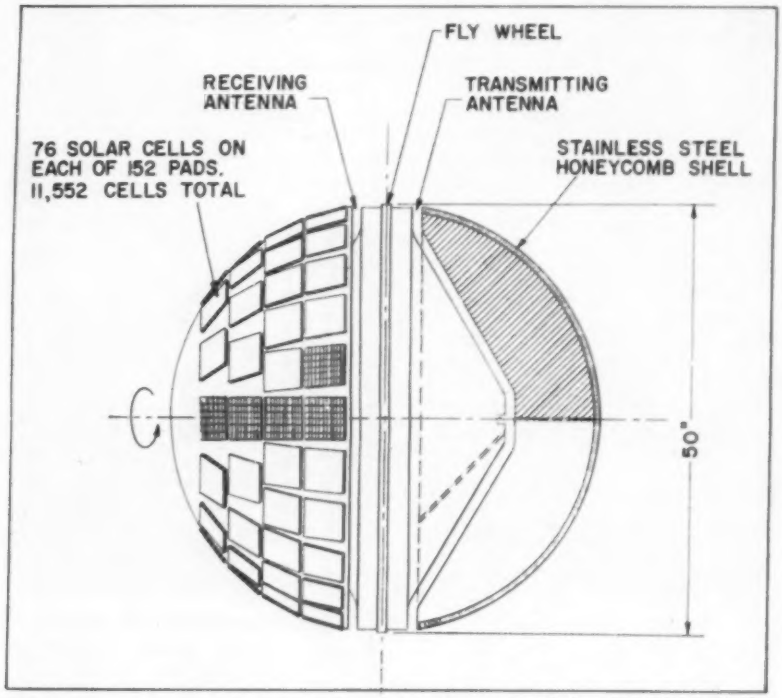
In addition to the two 100 mc. bands

British Discuss Satellites

Washington—British communications officials started a tour of U. S. industry and government facilities last week to explore possibilities of cooperating in future communications satellite programs.

Preliminary discussions are being held with Federal Communications Commission, National Aeronautics and Space Administration headquarters and Goddard Space Flight Center, Defense Department, Bell Telephone Laboratories, International Telephone and Telegraph Corp., Radio Corporation of America, American Telephone and Telegraph Corp., Johns Hopkins University, Army Signal Center at Ft. Monmouth, N. J., Air Force Ballistic Missile Division, Space Technology Laboratories, Massachusetts Institute of Technology, and the Air Force Command and Control Development Division.

The British group is headed by Maj. Gen. L. de M. Thuiller, (ret.), and includes representatives of the Post Office, Science, and Aviation Ministries and the Admiralty. The tour will end Nov. 16.



ACTIVE repeater communications satellite, which American Telephone & Telegraph Co. hopes to place in 2,200 mi. orbit within a year, will permit transatlantic television or provide voice/data channels. Subsequent operational models will provide both TV and voice/data channels. Satellite will weigh about 175 lb., be powered by solar cells.

requested for initial experiments, AT&T has asked FCC to allocate a full 500 mc. band between 6,425 and 6,925 mc. for subsequent use by operational commercial communications satellites.

The 200 mc. bandwidth sought for initial experiments will permit either one-way transatlantic television or voice/data communications, but not both.

Television transmission can be in either direction.

At the intended 2,200 mi. orbit, the satellite would have a period of slightly less than three hours. Maximum period during which the satellite will be in view of stations on each side of the Atlantic during a pass will be about 35 min.

The 500 mc. band that AT&T has requested for operational use would provide simultaneous two-way television or 600 telephone circuits, or a combination of both, AT&T says. Company adds that it believes a total of four 500 mc. bands will eventually be needed to handle growing traffic and that additional frequencies may be requested later.

On the subject of possible interference with existing domestic radio/microwave operations, the problem raised by AT&T in its July petition to FCC, the company says that "every effort will be made to avoid interference by means of coordination. . . . We are of the opinion that no interference will be caused to existing services in the United Kingdom or Western Europe by the use of the frequencies proposed."

Ling-Temco Reports Increased Earnings

Increase of 14% is reported in Ling-Temco Electronics, Inc., net earnings for the third quarter over the same period in 1959. For the third quarter, ending Sept. 30, Ling-Temco earned $823,000 after taxes, equal to 33 cents per share, bringing total first nine months after-tax income to $2,260,000 or 92 cents per share. Sales for the third quarter of 1960 totaled $39,369,000, with total sales for the current nine months period being $115,489,000 with a firm current backlog of some $100 million. Increased earnings were achieved in spite of certain non-recurring expenses involved in combining Ling-Altec Electronics and Temco Aircraft Corp. into Ling-Temco Electronics, Inc., Board Chairman Robert McCulloch and President James J. Ling said.

Plans to integrate the company's activities to accomplish more as a unit than the individual firms could do on an individual basis should increase the company's net profit margins in 1961, they add.

ARPA Studies Satellite-Borne Anti-ICBM Defense System

Washington — Advanced Research Projects Agency is considering the implementation of an extensive satellite-borne anti-ICBM defense system. Indications are that if the decision is made to go ahead with the plan, requests for proposals may be issued by the Air Force's Ballistic Missile Division for industry-wide competion soon, probably before the end of the year.

Boeing, Convair, Lockheed and Thompson Ramo Wooldridge have conducted feasibility studies for such anti-ICBM systems over the past year or more and are expected to be among the principal contenders.

In anticipation of the need for such a system, ARPA has been funding several studies of similar, but competitive anti-ICBM systems. These include the Random Barrage System (RBS), a program which would employ a multitude of armed satellites placed in random orbits for the purpose of destroying enemy ICBMs before burnout.

Now being studied in a follow-up phase at Thompson Ramo Wooldridge for Advanced Research Projects Agency and Ballistic Missile Division, Random Barrage System is competitive with Convair's Project Spad (Satellite Protection for Area Defense), another ARPA-supported program. Both Spad and RBS, previously referred to as a modified Spad program (AW Sept. 19, p. 23), would employ armed satellites capable of detecting, tracking and ultimately destroying hostile ICBMs. Original Convair Spad program envisioning use of polar orbiting satellites (AW Jan. 4, p. 18) was modified so that it too will use satellites in random orbits. ARPA is supporting studies on both programs for about $3 million a year each. This includes BMD contracts to study the effectiveness of guidance techniques for their respective programs. ARPA is also financing an anti-ICBM system feasibility study at Lockheed for roughly $3 million. Money for these studies is drawn from the $115 million a year budget of Project Defender.

While initially identified with the Convair program, the term Spad has come to be a generic description of any anti-ICBM system employing orbiting earth satellites.

The name Bambi, for ballistic missile boost intercept, also has been used to cover a number of anti-ICBM studies. USAF has assigned the designation Space Combat Weapon System 649E to the system that would grow out of these studies.

Still another program, this one entirely company-funded, has been under study for several years at Boeing Airplane Co. Thompson Ramo Wooldridge assisted the Boeing effort in its early stages and, more recently, systems analyses were provided by Electronic Specialty Co. Burroughs Corp. has been conducting reliability studies for Convair's Project Spad over the past year.

Cost of either the Thompson Ramo Wooldridge RBS program or Project Spad, should one of them be adopted as the nation's ICBM defense system, would be $15 billion, confidential sources here indicate. Neither system is expected to be foolproof, that is, capable of destroying every enemy ICBM launched. But both systems, like any effective aircraft defense system in its sphere, should make an ICBM attack against this country extremely costly and difficult.

The Random Barrage System studies were originally conducted at the Ramo-Wooldridge Division of Thompson Ramo Wooldridge but were switched to TRW's Space Technology Laboratories after the latter took over the military systems workload from TRW's Ramo-Wooldridge Division earlier this year. The RBS approach would employ a greater quantity of satellites than would the Convair Spad program, although the total number of anti-ICBM missiles employed in the satellites of either system would be roughly the same. For example, each RBS satellite might carry one counter-weapon, while a Spad vehicle might have six, but the RBS would req ire approximately six times as many satellites.

An important political question complicates the decision which must be made about ICBM defense. Public reaction abroad may be unfavorable to placing an armed satellite system in space despite assurances of its defensive intentions. It may be difficult to convince others that RBS, Spad or any other armed anti-ICBM satellite defense system would include a built-in capability for being rendered harmless on re-entry in the event of a malfunction in the satellite.

A proposal for another Spad-type system which could extend the time allowed for kill while the missile is still in its launch phase is being readied for submission to ARPA by Electro-Optical Systems, Inc. This approach is based on a novel detection device which would enable the satellite to spot a missile launch sooner and thus allow more time for a kill during launch. The system appears feasible against IRBMs as well as ICBMs.

French Nuclear Strike Force Plan Dubious Despite Assembly Consent

Paris—Considerable doubt surrounds the future of the French government's plan to develop an independent nuclear strike force despite reluctant approval by the French Assembly.

The nuclear strike force is a portion of the government's five-year military plan which stretches from January, 1960, to January, 1965. In this period the French expect to spend about $6.232 billion on various military projects. However, the published five-year plan placed before the Assembly for approval contained only these projects which, because of their long lead-time, have to be planned over several budgetary periods.

Thus the Assembly debated a military program of some $2.558 billion. Included in this amount were funds totaling $1.150 billion earmarked to help finance the government's ambition to develop a nuclear strike force. It was this particular ambition that came under heavy criticism during the week-long debate, one of the hottest in the two-year history of the Fifth Republic. Deputies criticized the nuclear strike force concept on both political and technical grounds.

Politically, many deputies felt the strike force project was isolating France from its Atlantic alliance partners. If France must develop such a force, many deputies argued, it should be developed on an integrated basis with the country's NATO partners. It was also argued that if France insists on its right to develop such a force, it will be impossible to prevent the West Germans from seeking the same right in the future—despite current bans on German nuclear armament.

Government replies to such political criticism were that France had tried again and again to develop nuclear armaments with the help and cooperation of its NATO partners, particularly the U.K. and the U.S., but each time had been refused. Defense Minister Pierre Messmer revealed the government tried for 15 months to get an agreement within the Atlantic alliance to build in common an isotope separation plant for military purposes. Messmer implied that U.S. pressure blocked the French move.

Technically, many deputies expressed documented doubts that the government's plan really would yield a nuclear strike force that would have valid military meaning. In particular, special criticism was levied at the use of the Mirage IV twin-jet bomber—of which a single prototype is now flying—as the backbone of the nation's atomic strike force until 1970. By then the French hope they will have developed ballistic missiles to replace the Mirage aircraft.

The government's $1.150 billion financing program for its nuclear strike force breaks down in the following manner:

- **For 50 Dassault Mirage IV** twin-jet bombers to be operational by 1965—$200 million.
- **For research and development** of nuclear weapons, including $30 million to be spent on an isotope separation plant —$800 million.
- **For development and preproduction** of ground-to-ground strategic and tactical ballistic missiles—$150 million. Tactical missile development will take $20-30 million, of the total.

Under present plans, France's atomic strike force would come into being in two stages.

The first stage would be achieved by 1965. Then, France's atomic strike force would consist of 50 Mirage IV twin-jet bombers carrying plutonium-type nuclear bombs.

The second stage would come about somewhere between 1968-1970. Then the French would replace the Mirage aircraft with tactical and strategic ballistic missiles equipped with nuclear warheads using enriched uranium produced by the isotope separation plant provided for under the five-year program. This plant is slated to be in operation by 1966.

Much of the Assembly criticism centered on the first stage approach. Some deputies thought that in the years 1965-70—when the Mirage bomber very likely will represent French nuclear power—any deterrent based on aircraft will be useless.

Moreover, some criticism was centered on the range capabilities of the Mirage IV. Mirage builder, Avions Dassault, apparently testified that the production version of the Mirage IV will be capable of carrying its atomic load between 1,500 and 2,200 mi. at speeds approaching Mach 2.2. These figures, according to Assembly debate, were challenged. The debate also revealed that the French are planning to use a glider-type atomic bomb which will have a glide range of some 220 mi., thus easing the Mirage IV range difficulties.

Moreover, the debate further revealed that the government, in committee testimony, had admitted that France wouldn't have an important stock of plutonium-type bombs before 1968. Thus some deputies questioned the value of having a fleet of 50 Mirage IV jet bombers ready by 1965. In sum, the public debate waged in the Assembly seemed to indicate that France would not have a valid atomic strike force—based on ballistic missiles—before 1970.

Defense Supplemental

Washington — Defense Department plans to ask Congress for a supplemental appropriation in January to cover costs of the decision last summer to retain two B-47 wings scheduled for deactivation and to send two extra carriers loaded with attack aircraft to the Sixth and Seventh Fleets.

Services now are paying for this from regular budgets. The carriers are costing an added $500 million a year. Defense still has some $280 million unallocated from extra funds voted by Congress, but most of it is slated for Army modernization and the B-70. It now has apportioned an extra $8 million from frozen funds to anti-submarine warfare research.

News Digest

First Polaris submarine the George Washington, will be at sea and operational Nov. 15. The second, the Patrick Henry, is scheduled to reach operational status before the end of the year.

Navy will manage a four-year joint service program to develop a VTOL transport prototype for operational testing. A design competition will be held, based on type specifications written to cover requirements of the Navy, Air Force and Army, and the program will be funded equally by the three services.

Discoverer XVI, first attempt to fly the Lockheed Agena B, failed last week when the Agena B failed to separate from the Thor booster. Re-entry capsule weighed 300 lb. Orbital weight after fuel exhaustion was to be 2,100 lb. as against 1,700 lb. for Agena A.

Lockheed California Division received a $53 million production contract last week for the P3V-1 ASW patrol aircraft, bringing total production orders to $126,836,691. P3V is powered by Allison T56-A10-W engines and Hamilton Standard propellers.

New "compact" two-place Piper Colt sportplane will be unveiled this week at Grand Bahama Island by Piper Aircraft Co. during its annual dealer-distributor meeting. Tricycle-geared plane is powered by a 108 hp. Lycoming O-235 engine. Price will be below $7,000 and production is planned for early in 1961.

Hughes Faces Crisis on TWA Financing

Creditor banks begin deducting amounts owed on notes from airline's accounts as directors meet.

By William H. Gregory

New York—Trans World Airlines' almost-completed $300 million jet financing program was stalled again last week and there were indications that the long-predicted crisis was finally at hand for Howard Hughes, who owns 78% of TWA's stock.

Hughes appeared by weekend to have forestalled any immediate drastic action by lenders but it was evident that the inexorable, slow increase in pressure on Hughes and the airline had not abated.

TWA's board of directors went into session Tuesday, met again all day Wednesday and began its third day's session Thursday. Little specific emerged from the sessions, but one point was known—offsetting of TWA bank balances by creditor banks began the same day the board began its meeting.

This legal step is open to banks which hold both note installments due and payable and also are cash depositories for the debtor, which is usually the case since banks frequently require their debtors to keep compensatory balances with them. In offsetting balances, the banks simply deduct amounts owed on notes from the debtor's accounts.

TWA reported cash on hand of $36 million to the Civil Aeronautics Board in August, the latest month on file, indicating that this step in itself would not be catastrophic for the airline. TWA's August statement showed $5,931,889 in current notes payable, but did not indicate whether this was owed entirely to banks or to Hughes Tool Co.

Despite the possible ominous implications of offsetting balances, it had the saving grace for Hughes in that the step appeared to satisfy the banks for the moment, giving Hughes and the airline a pause for breath.

Even so, two other possible problem areas existed:

- **Equitable Life Assurance Society** had $26 million in equipment mortgage bonds at the beginning of the year and TWA may be technically in default under certain terms of the loan. Equitable could take action but is not expected to do so as long as hope still existed for eventual over-all new financing.
- **Lease payments** to Hughes Tool Co. for jet aircraft now operated by TWA cannot be made without approval of the holders of TWA's funded debt. In latest available reports to CAB—for the year ended June 30—TWA listed rental payments of $15 million for jet equipment under operating expenses. Size of the amount indicates the lenders have already halted these rental payments and that they are being accrued for release when the financing is settled.

Hughes two weeks ago had agreed in principle to accept a plan to place his stock in a voting trust consisting of two representatives of the lenders and one of Hughes Tool as a condition for obtaining the $300 million (AW Oct. 17, p. 41).

As it turned out, Hughes' acceptance was a yes-and-no affair. The following week Hughes came back with some conditions, an important one being that in exchange for the voting trust concession he be allowed to buy back the debt. Thus if he were able to obtain alternate financing in the future, possibly combined with cash generation from TWA or Hughes Tool funds, his loss of sole control could become only an interlude.

After some further talks, the night of Friday Oct. 21 was set for the final signing of the agreement. But Hughes was adamant on the pre-payment condition. On the other hand, some of the lenders—reportedly Metropolitan Life Insurance Co. in particular—were equally opposed. Their attitude was that since the program had required such long, arduous effort on their part, they wanted the full benefit of the long term loans at 6% interest and would accept pre-payment only at the price of a very high penalty clause. At that point agreement stalled again.

Hughes is known to feel that the financial community would not remain united with the prospect of such a large lending plum at hand. He began conversations last week with a new group of investment bankers, Brown Brothers, Harriman and Ripley, to seek an alternate financial plan for TWA.

His degree of success was not immediately known and probably would not become so because of the great complexity of financing of this order. The so-called Dillon Plan, named for Dillon, Read & Co., which Hughes had been at the point of signing, was two years in the making. Presumably it is still available if Hughes is willing to accept the terms.

It was plain to this observer last week that the climate in Wall Street had changed considerably for Hughes. As late as two months ago non-participating financial people regarded TWA with Hughes in sole control as a basically sound credit risk and there was doubt Hughes would capitulate to the voting trust plan.

As the Dillon Plan moved through what seemed to be interminable backing and filling, the dwindling interest of non-members of the lending group became apparent.

As one said recently: "Sure, we'd like to participate in a TWA program, but we'd want to be asked to make a commitment by the lenders after they had the program all signed and sealed with Hughes. If it was a case of becoming a principal, we feel we would want just about the same conditions the present group wants."

The pressures on Hughes Tool Co., which has a TWA order for 30 Convair 880s in its name, could only be surmised since Hughes Tool is a privately, not publicly held, corporation. Twelve 880s are waiting on the ramp at Convair for delivery to TWA, and some of the 17 other aircraft are now in production.

Of 15 Boeing 707-131s it operates, TWA now owns two; of 12 Boeing 707-331s it owns eight, and it owns the one Convair 880 that has been delivered. All other jet equipment operated is leased from Hughes Tool Co.

Convair has had to disrupt its production schedules and has had its Convair 600 program interfered with because of the delay. General Dynamics, though keeping officially silent, can scarcely conceal its impatience to deliver the airplanes and receive the rest of the payment due. Convair has suffered the disadvantage of not having the operating experience of a big TWA fleet as a possible source of data for its sales campaign.

TWA itself is beginning to feel the pinch of the situation over which it has no control. United Air Lines has begun to operate its Boeing 720s and so has American Airlines, and TWA is finding it tough to compete with them with piston-engine equipment in certain markets.

N. Y. Port Authority Takes Delta To Court Over Idlewild Jet Noise

By Glenn Garrison

New York—Action by the Port of New York Authority last week in seeking a state court injunction to restrain Delta Air Lines from violating the agency's jet noise procedures at Idlewild is expected to bring to a head a long-standing conflict concerning the authority's power to enforce anti-noise requirements at its airports.

The Port Authority filed a complaint in the Supreme Court of the State of New York in Queens County asking an injunction to restrain Delta from violating the agency's rules and regulations. The action should provide an important test case of the airport operator's jurisdiction in an area that affects actual flight operations.

Under its original jet noise rules, the Port Authority specified certain actual procedures the airlines were to follow after takeoff, including power settings and turns. The rules later were modified to require certain results and to leave the actual techniques of achieveing them to the carriers. The rules also include a preferential runway system.

Federal Aviation Agency on Oct. 15 instituted its own set of noise rules at Idlewild, differing in two important respects from the Port Authority's: the FAA rules permit night takeoffs on some runways the Port Authority rules prohibit, and the FAA rules do not set maximum noise levels over adjacent communities, as the Port Authority rules do. The Port Authority has said that its rules would remain in effect regardless of this discrepancy.

Delta, the Port Authority charged, ". . . has repeatedly planned and conducted its jet flights in disregard of both the Port Authority prohibition against jet departures except over water between 10 p.m. and 7 a.m. and the limitation of 112 perceived noise decibels (PNdb) over the communities neighboring the airport."

Delta, the agency charged, has shown a high percentage of violations, particularly during night takeoffs and with respect to noise levels. At times, the Port Authority said, Delta's jets have exceeded 120 PNdb or nearly twice the limit.

Delta last summer scheduled a nightly Convair 880 coach flight out of Idlewild, and this has produced "conspicuous" violations, according to the Port Authority. Of 30 scheduled takeoffs of this flight during September, the agency said, 18 or 60% violated the rules.

Port Authority and Delta officials met in New York Oct. 14 and, the Port Authority said, Delta was informed that action would be taken unless the violations ceased. Additional night violations followed on Oct. 16 and 18, the agency charged.

Delta told AVIATION WEEK that H. G. Farnsworth, chief 880 pilot, had come up from Atlanta for the meeting and that since then it believed the situation had improved and that pilots were following "the spirit and the letter" of the rules. The airline said it thought the matter had been settled "amicably."

It came as a surprise, according to Delta, when the action was taken and that apparently the Port Auhority had been preparing its complaint for some time.

Since the matter has advanced to the point that it has, Delta said, the airline wants to go ahead and resolve the issue. It expects support from the rest of the industry.

According to some reports, Delta pilots have been making takeoffs in the 880 from Idlewild with fairly flat climb-out profiles. The airline said that this might have been true to some extent before the meeting, but not after it.

Delta also operates the Douglas DC-8 from Idlewild, and the Port Authority's violation tally includes operations with this aircraft. The agency said Delta's September record included 51 violations out of 140 jet takeoffs, or 36.4%. Of 2,847 jet takeoffs by all airlines at Idlewild during the same month, according to the agency, some 308 or 10.8% were in violation of the rules.

This over-all September percentage compared with 396 violations out of 1,259 jet takeoffs last January, or 31.5%, the Port Authority said, indicating a steady decline in noise violations.

The Port Authority said Delta's record has worsened over the months despite "repeated written and oral assurances."

National Air Transport Coordination Committee, a regional industry organization concerned with community relations and the aircraft noise problem, had no comment last week on the Port Authority action against Delta. NATCC has previously clashed with the Port Authority, once active in the organization but now not associated with it. NATCC had its own voluntary rules for all aircraft at the New York airports, but these were superseded by the FAA regulations. The NATCC rules were less restrictive than the Port Authority's, and NATCC-Port Authority disagreement broke into the open a couple of years ago. At that time, NATCC contended that only confusion could result from two sets of rules at the field.

Delta said last week that frequently FAA tower clearances and Port Authority preferential runway requirements conflicted, and that Delta was "between the devil and the deep blue sea."

But the Port Authority charged that other aircraft operators have performed satisfactory takeoffs under conditions substantially similar to those existing at the time of violations by Delta.

The agency's action increases the uncertainty as to when jets will be allowed into Newark Airport on a scheduled basis. Delta is the only airline that so far has officially asked the Port Authority for permission to schedule jets at Newark, and the agency has said that the carrier's performance at Idlewild would be a determining factor in granting permission at Newark.

Eastern Seeks New No-Reservation Service

New York—Expansion of Eastern Air Lines' no-reservation, low-fare service to Miami was proposed last week as the carrier planned to file a tariff with Civil Aeronautics Board to add Cleveland-Miami and St. Louis-Miami services to the existing Pittsburgh-Miami service (AW Sept. 19, p. 47).

Eastern on Oct. 14 inaugurated the service from Pittsburgh. Designed to compete with surface transportation, the Air-Bus flights, as Eastern designates them, are no-frill, high-density services.

One-way fare from St. Louis to Miami under the proposal will be $40; from Cleveland to Miami, the proposed fare is $42. Eastern said this is a 29% reduction from daytime coach fares on the routes. The Pittsburgh-Miami fare is $40.

Advance telephone reservations are not required under the plan. Seat confirmation is made at the time of ticket sale. Purchase of one-way or round-trip tickets may be made up to 90 days in advance from Eastern offices in origin cities, or through authorized travel agents. No reconfirmation is necessary. No penalty for cancellation is imposed if the cancellation is made 24 hr. or less before departure time. The proposal calls for forfeiture of the entire ticket price unless it has been turned in before that time, but CAB is still studying this facet of the proposal. The forfeiture provision has been in effect in the Pittsburgh-Miami service.

Baker Traces History of Capital Troubles

By L. L. Doty

Washington—Capital Airlines, about to lose its corporate identity through acquisition by United Air Lines, stands out as an economic case history in the evolution of the domestic trunkline industry.

The carrier—the nation's fifth largest until it became bogged down with financial difficulties—has, for all practical purposes, reached the end of its 33 year career as an individual part of the U.S. transportation system. Only CAB approval of the merger, which is expected, is now required to open the way for absorption by United and thus eliminate Capital as a corporate entity.

Capital's history, its growth and development, will attract the study and evaluation of economists and analysts searching for the basic reasons behind the company's decline and fall. Current CAB hearings in the merger case have brought much of this background out into the open, but most testimony has centered around the need for the merger rather than the reasons the need developed in the first place.

In an effort to trace the causes and events which led to the Vickers receivership suit and ultimately to the United merger plan, AVIATION WEEK has discussed Capital's problems with President David H. Baker.

For more than three years, Baker, as president, has been intimately associated with Capital's financial dilemma, which reached its first climax a little over a year after he took office when Vickers-Armstrongs urged Capital to "as a matter of utmost urgency, take immediate and active steps to seek an appropriate merger." This advice followed default on the Vickers loan in 1958.

In a detailed analysis of Capital's situation, Baker tried to determine the exact causes of Capital's fiscal plight. Here are the major factors which Baker found existing in 1957 and which he believes blocked the carrier from attaining financial strength and prevented it from being an effective airline competitor:

• **The airline failed to divest** itself of unprofitable routes and seek longer haul routes or consider a merger. He said these three basic approaches were open to management in 1957. He charged that management's relationship with the CAB staff, "in my opinion," were unsatisfactory, noting that community and state relations were being handled as a part time job. He added that in 1957, Capital had no practical plan for improving its position and that it was not organized to attain or implement a plan even if it had one.

• **Capital's equipment program** failed to include plans for the retirement of outdated aircraft costly to operate, Baker said. He had no direct criticism of the Vickers Viscount turboprop transport, 59 of which Capital had in 1957, as an airplane. However, he said it was not "well adapted" to Capital's route structure in cargo and seating capacity or range. He observed that with a maximum range of 1,100 mi., or less than half that of any competitive aircraft, it had to cancel on the longest and most profitable routes in bad weather and, at other times, had to land en route for refueling.

• **Viscount profit potential** on Capital's routes with U.S. tariffs was, and is, less than half that of any competitive modern equipment, Baker said. He charged that the decision to cut the number of seats on the Viscount from 48, as originally planned at the time of purchase of the aircraft, to 44 cost Capital at least $9 million in profit potential. He also said that the airline industry has been able to meet expanding expenses by increasing speed and capacity per airplane at a planned rate. With the acquisition of the Viscount, he pointed out, Capital gained temporary speed equality, but lost in capacity. Capital's capacity dropped from 43.7 seats per aircraft in 1955 to 43.6 in 1957 while other regional carriers' capacity increased from 53.2 to 57.8 seats in the same period.

• **Baker was especially critical** in the area of management and said there was a lack of "planning, objectives, policies and organization." He charged that there was a "serious clash" between the operations and sales departments which affected operations and individual relationships to a major degree. He added: one person, the chairman of the local mechanics union, exercised as much influence over the operation of the company as did any individual in management. He said there was no formal top level group to consider and recommend policy and no specified organizational responsibilities. Important function of passenger policy was split, he said, and there were no wage standards, no personnel evaluation system, no annual management audit and "the company did not even have a suggestion program."

• **Baker said the airline** had a higher percentage of organized labor than any other airline. Capital paid mechanics more than any other airline, but he said there was major unrest within the company because of labor negotiations with the mechanics union, "which was completely undisciplined."

• **Baker said Capital** had been living on a day-to-day basis financially while other carriers were developing long-range financial programs. He said that no efforts had been made for public financing, particularly when acquiring the Viscounts, and that the carrier's financial condition was "inflexible, marginal and certainly critical." He said the airline had 21.5% of all the debt outstanding among regional carriers in 1957, and in that year, its debt was 3.89 times its equity, "the poorest in the industry." Fixed interest charges of the company, he noted, were equal to 37% of all interest assumed by all regional carriers.

• **Capital's earnings position** was satisfactory when its depreciation was below industry levels, he said. However, with the purchase of the Viscounts, Capital's depreciation increased to 10.9% of revenue, compared with an industry level of 9.3%. Baker then said that, with annual depreciation of $10 million, interest payments and capital expenditure requirements, Capital, in effect, "had agreed to pay [Vickers] $6.9 million in 1958, $9.2 million in 1959 and about $11.2 million in 1960 in excess of the depreciation cash throw-off after provisions for capital expenditure and interest plus whatever permanent increase in working capital requirements accompanied the growth in operating expenses and revenues."

Baker has concluded that many of Capital's current difficulties stem from the failure of Capital's management in the late 1930s and early 1940s "to visualize the future development of air transportation from DC-3 operations

PanAm Freight Service

Pan American World Airways has entered into an agreement with Railway Express Agency under which the two carriers will offer international air-surface freight service on a single-charge basis. Through 14 gateway cities, the agreement links PanAm's global route structure with 20,000 U.S. communities served by REA. Granting of statehood to Alaska and Hawaii gave Pan American "domestic airline status" and made it eligible to join the Air Express Agreement between REA and 35 U.S. airlines, PanAm reported.

duplicating the Pennsylvania Railroad in the air to the entirely different operation experienced in 1950 and 1960."

Baker began explorations of merger possibilities in December, 1958, when, at a Board of Directors meeting, a special committee was established for the purpose of studying merger potential. The committee consisted of five board members, including Baker.

During the ensuing period, formal economic studies of merger possibilities with eight airlines or combinations of airlines were made, and direct approaches with other carriers began. In all, informal discussions of possible mergers were held with TWA, Eastern, Braniff, Delta, Northwest, and Northeast. United was the last carrier to be contacted.

As part of his effort to correct the difficulties in Capital's operations, Baker developed a financial program designed to provide long-term financing for new turbine equipment and to stretch out the Vickers debt from 1961 to 1970 at an average interest rate of 4½% instead of 6¼%.

A meeting was held with Vickers in England on Apr. 28, 1959, to consider the feasibility of launching the new financing program at the same time the merger studies were being conducted. Since it was apparent that the proposed program lay within the realm of possibility, Capital put first priority on the equipment-finance project, and contacts for mergers were placed second in order of importance.

The over-all plan called for retirement of nine DC-3s and three L-049s in 1959, with full retirement of three remaining L-049s by July 1960. A full fleet of 11 DC-6Bs, which were leased in 1959 for 18 months at $12,500 each per month, was slated to replace the old aircraft. Balance of DC-3s were to be retired when small stations were released from Capital's routes structure by the CAB. Purchase of Convair 880 turbojet transports and Lockheed turboprop Electras was included in the program.

To increase capacity, seats in the Viscounts were increased from 44 to 46 by eliminating one lavatory, and further plans were made to increase the number to 50—the equivalent of adding eight Viscounts to the fleet from a seat-mile capacity standpoint, according to Baker.

Meanwhile, Baker established a department to coordinate route matters, bids were made for route extensions to San Antonio, Houston, Dallas and Toronto and a firm plan was developed to obtain authority to withdraw from 13 small stations. The carrier was granted a Great Lakes-Florida route in 1958 and a Minneapolis-Chicago route in 1959.

Six new management members were brought into the company by Baker in a reorganization move. An organization manual was published and an executive management council of the top six officers was created to consider major policies and decisions. All matters affecting expenses were controlled by a budget committee created with six officer members. A corporate affairs department and marketing and planning departments were established.

A management analysis unit was formed to evaluate company performance and the development of an organization and plan for all maintenance functions and facilities was provided for by retaining Wallace and Clark Consultants.

Baker made several moves to increase revenue, including an increase in Viscount utilization from 8:11 hr. in 1957 to 9:03 hr. in 1959. According to Baker, Capital's load factor in 1959 was second highest of all regional carriers compared with fifth place in 1957, and its load factor of 58.4% in 1959 compared with a regional average of 55.3%. He added that, despite this performance, Capital's revenues increased from $94.1 million in 1957 to only $108.5 million in 1959. He gave this reason for the relatively slight rise:

"Capital's inability to add seat miles in carefully planned increments as our competitors had was the basic reason why over-all revenues did not go up as rapidly as other carriers even though acceptable criteria, such as load factor, showed outstanding results."

Baker's move to halt a steadily rising expense level included a 13% personnel cutback in July, 1958. In 1959, the airline was able to cut over-all expenses by 3.6%, and budgeting and expense control techniques were introduced into the carrier's operation, Baker said.

During the first quarter of 1960, Capital suffered severe financial reverses which, when coupled with the drop in all airline stocks, made implementation of the carrier's financial program impossible. According to Baker, it then became highly evident that the only solution to Capital's problems rested in a merger with a strong airline. According to Baker, Vickers apparently came to the same conclusion and announced its foreclosure action on Apr. 12, 1960 (AW Apr. 18, p. 38).

In May, W. A. Patterson, president of United, was contacted and merger discussions began. Meanwhile, a program was presented to Vickers-Armstrongs outlining a program involving a merger as a means of settling Capital's indebtedness to the manufacturer. The program also called for a change in the organization of the board of directors of Capital, including the election of Thomas D. Neelands as chairman of the board, and changes in the management structure.

Various attempts were made during talks with Vickers to defer the foreclosure action pending the merger investigation. Baker held, in a letter to Vickers, that satisfactory negotiation would be possible only if all obstacles, such as the foreclosure suit, were removed until an agreement was reached.

Baker also felt at the time that cash payments to Vickers in excess of interest charges would be available. Expense reductions coupled with a fare increase gave some promise of additional funds, and the sale of aircraft provided additional opportunities to make such cash payments, he said.

He suggested that continued operation of the Viscount fleet, combined with a settlement of equipment notes at the time a merger would be consummated, was the best way of settling noteholders' interest. At the same time, he proposed that partial payment toward principal could be made by the sale at book value or better of a reasonable number of Viscounts. Reduced capacity, he said, could be replaced by short-term leasing of aircraft pending a merger. He added that such a gradual sale of aircraft would help the carrier to escape the disadvantages of a distress sale of the entire fleet, provide an orderly replacement of equipment and avoid "the spectacle of an airline without aircraft to service its authorized route."

Vickers agreed to several postponements of its foreclosure action while discussions were under way with United, and the merger plan concluded late in July (AW Aug. 8, p. 40). Vickers has supported the merger plan but has warned the CAB that if the merger is not approved, the British company will proceed with its foreclosure effort.

Supplemental Airlines Win Court Approval

Washington—Supplemental airlines won a major legal victory last week when the Supreme Court overruled an appeals court decision which challenged the authority of the Civil Aeronautics Board to certificate them.

Directing the U. S. Court of Appeals to vacate a judgment issued against a CAB decision in the Large Irregular Case, the Supreme Court further ordered the appeals court to retain jurisdiction over the case until further legislative action or until the expiration of a law signed by President Eisenhower last July to extend the airlines' authority for a 20 month period.

In another action, Delta Air Lines was denied review of a court of appeals decision which upheld a CAB order directing the airline to pay back more than $1,795,000 in subsidy formerly paid Chicago and Southern Airways, which was absorbed by Delta in 1953.

State Regulation Threat Worries Airlines

By Robert H. Cook

Washington—Current legal battles between Bonanza and Frontier Airlines and the states of Nevada and Nebraska are being followed with concern by many airlines, which fear that judicial support of these states' regulatory moves could encourage other states to enforce a complex of intrastate airline regulations which have lain dormant for many years.

Revolving around the issue of states' rights versus federal regulation, the two cases are regarded as a direct challenge to the Civil Aeronautics Board's powers in permitting local service and trunk airlines to abandon or suspend intrastate service over the objections of state aeronautical or public utility commissions.

While the cases in Nevada and Nebraska are concerned only with service, similar legal questions of state authority opposed to CAB authority exist in other states on issues of airline certification and fares.

CAB Hasn't Intervened

So far, the CAB has not intervened in these court cases, but the Board could later be forced to do so if the state courts uphold Nevada and Nebraska, which ordered the two local service carriers to continue service after they were permitted to abandon it by the CAB.

Caught between state and federal orders, Bonanza and Frontier are faced with heavy fines and penalties from the states if they drop the service and probable federal subsidy loss if they retain it.

Pointing out that CAB has been attempting to curb its rising subsidy bill by such measures as the "use it or lose it" formula under which the two airlines were permitted to drop the disputed service, CAB says it may be forced to firmly establish its authority on these and other similar issues through a series of lengthy court proceedings or by seeking an amendment to the Federal Aviation Act.

While these problems are being faced in only a few states now, their scope could be expanded considerably since 37 states have constitutional or statutory control over varying phases of air transport within their borders. Although a majority of these states have not attempted to apply these powers, 22 have some form of control over airline rates, 16 can require local airlines and trunklines to obtain approval for any intrastate operations and 18 have regulations requiring the filing and approval of all tariffs before their implementation within the state.

Although the possibility may seem remote at this time, there is also a danger that any state legal victory might lead to a revival of interest in railroad-sponsored legislation which would give states broad powers over airline operations through existing state railroad or utilities commissions. Such legislation was introduced 15 years ago in 22 state legislatures, but it was enacted only by Alabama, Arkansas and Vermont in a diluted form.

What Bill Requires

Prepared by the National Assn. of Railroad and Utilities Commissioners, the bill would require interstate carriers to secure certificates from the state for intrastate operations; would subject the carrier's intrastate rates to local controls and its interstate rates to state investigation, with the airline held subject to suit for reparations by the state commission would require tariff filings and could force the carrier to extend its routes within the state or halt the severance of existing services.

With the Bonanza and Frontier cases, plus growing problems in California, Illinois and elsewhere, airlines already are facing in a piecemeal fashion the major disadvantages which the NARUC legislation would have created. Carriers may have to take positive action to avert any move the states might make to increase their present control over interstate operations. As an example, airline attorneys point to California, which for years has imposed rigid tariff filing rules on the airlines and is now considering legislation to expand its powers to require state certification of interstate carriers serving any intrastate routes.

Immediate Threat

In the more immediate future, many airline observers view the use of state powers as a possible threat to CAB's efforts to aid carriers in dropping poor revenue-producing points and to the Board's expected use of a class mail rate plan which determines subsidy payments on specific routes with a sliding scale based on schedule frequencies.

In the case of Bonanza, the airline was certificated by the State of Nevada as an intrastate airline in 1946 over a Reno-Las Vegas route which later included the cities of Hawthorne and Tonopah. Several years later, the airline was granted a certificate for interstate operation by the CAB and last year notified the Public Service Commission of Nevada that it intended to drop service to Hawthorne and Tonopah on the basis of CAB approval, which the airline maintained has precedence over state authority.

The Nevada commission ordered the service reinstated in October, 1959. The airline obtained a temporary injunction against this order but lost its request for a declaratory judgment and permanent injunction when a majority decision of a three-judge court ruled that the case did not come under federal jurisdiction. In a dissenting opinion, the third judge held that the case should have been heard on grounds that reinstating the service would be costly to Bonanza and that merits of the case raised a question of the legality under federal law of demands made by the State of Nevada.

The case later was filed in Nevada's 2nd Judicial District Court, and was heard in September on a different set of facts, since the airline's original action was based upon a CAB exemption order. A subsequent Board order, issued last July, deleted the two cities from the airline's routes. No decision had been reached by the court late last week.

Frontier Case

While Bonanza's case has involved only two points within the state, Frontier Airlines faces a similar problem with two whole route segments in Nebraska. On the basis that its Segment 13, serving the cities of Chadron, Valentine, Ainsworth, Norfolk and Columbus, was producing only 3.8 passengers a day on an annual subsidy need of more than $240,000, Frontier was authorized by the CAB Aug. 9 to suspend this service.

Ten days later, the Nebraska Railway Commission passed a new regulation requiring its approval before airlines may drop or curtail any service to intrastate points. On the strength of this regulation, the commission also obtained a temporary injunction from a state court forcing Frontier to continue serving the segment. At the same time, the Nebraska Aeronautics Commission, overruled in the route case by the CAB, asked for review of the Board suspension order by the Court of Appeals in St. Louis, Mo.

Last week, Frontier moved to block repetition of this state action by asking the U. S. District Court in Lincoln for an injunction to bar the state from preventing a reduction of Frontier's service to Sidney, Imperial, McCook and Kearney on Segment 11.

On the question of whether CAB would continue subsidy payments for a

route which it had ordered deleted, Nebraska told the St. Louis court that it thought the Board would continue them, a point which many carriers regard as an optimistic conjecture. They point to CAB's concern over the mounting subsidy costs and to a recent Board order giving Southern Airways several Tennessee points formerly on the routes of Southeast Airlines. In the order, the Board implied that if the state had been willing to assume Southeasts's subsidy costs, the points might have been left on the intrastate airline's system.

Although the Bonanza and Frontier cases are now the focus of industry attention, airline problems with state regulatory bodies in the past have caused heavy financial losses to several interstate carriers in the field of tariff filings.

California, which requires tariff filings for all intrastate operations and approval by the Public Utilities Commission before they may be placed into effect, is cited most often as a case in point because of its Los Angeles-San Francisco intrastate traffic.

Although the recent general passenger fare increase of 2.5% plus $1 became effective in July and was filed with the California PUC under tariffs of Western, United and Trans World Airlines, the carriers have not yet been permitted to charge the higher fare over the intrastate route pending a decision from the commission, which held hearings on the increase last month. Western estimates its lost revenues on the route at nearly $170,000 so far, while TWA sets this figure at about $40,000 and United, with the heaviest schedules, estimates the loss to date at $500,000.

This same problem can work in reverse, as indicated by the experience of Western when it applied a higher coach fare, with CAB approval, nine years ago on the Los Angeles-San Francisco route without prior approval of the PUC. Final approval of the fare by the commission, more than two months later, also carried an order that Western rebate $1.75 for each ticket sold for intrastate travel over the route in the period preceding PUC approval.

While the over-all problem of state regulation is not presently widespread, it can present a variety of minor irritations. American Airlines, for example, which holds an intrastate certificate from the State of Illinois, is awaiting action by the Illinois Commerce Commission on a position to abandon service at Peoria and Springfield. The commission heard American's request last month, but has not yet announced a decision.

CAB Reports to Congress on Electra Crash

By Ford Eastman

Washington—No evidence of a structural failure that would have caused the crash of an Eastern Air Lines Lockheed Electra in Boston harbor Oct. 4 has been found, the Civil Aeronautics Board said in a progress report to Congress.

CAB did report, however, that there is evidence of a "foreign object strike" on the No. 1 engine air scoop prior to impact, and this engine appeared to have been shut down and its propeller feathered before impact. There also was evidence of starling feathers in the air scoop and oil cooler of engines No. 2 and 4 and foreign matter in engines No. 1, 3 and 4, but no indication of mechanical difficulty or malfunctioning has been found in engines No. 2, 3 and 4.

The accident investigation progress report was sent to Sen. A. S. Mike Monroney (D.-Okla.), chairman of the Senate Commerce Aviation Subcommittee, and Rep. John Bell Williams (D.-Miss.), chairman of the House Commerce Subcommittee on Transportation and Aeronautics, by CAB Chairman Whitney Gillilland. The House group plans to investigate the whole Electra situation after the election.

The report appears to support Federal Aviation Agency Administrator E. R. Quesada's statement that there was no evidence of a structural failure involved in the accident (AW Oct. 10, p. 37), which was the fifth in less than two years of service for the plane. But it is not conclusive regarding his contention that the accident might have been caused by flying into a flock of starlings.

Chairman Gillilland warned that the information in the report is of a preliminary nature and could be changed by further investigation and evaluation. He said the Board is pressing its field investigation so that a public hearing can be held as soon as possible. Seven teams, each highly specialized in certain technical fields, are being used in the investigation under direct supervision of the CAB.

Approximately 95% of the aircraft structure and all four engines and propellers have been recovered, the report said. In addition, about 95% of the flight and engine instruments, 90% of the hydraulic power section equipment, 80% of the fuel valves, 95% of the radio equipment and 50% of the air conditioning and pressurization equipment have been recovered. All flight control boost packages have been recovered. Dragging operations are bringing up additional small parts and an almost complete recovery is hoped for, the report said.

"The Structures Group has indicated that all three landing gear were in the full retracted position," the report said. "Both wing flaps were at the takeoff setting. It has also been determined that the aircraft struck the water vertically slightly left wing first and while rotating to the left. The Nos. 1 and 2 engines broke up and over the left wing and the Nos. 3 and 4 broke down and under the right wing."

All flight control surfaces were recovered and nothing abnormal was found in the control cables, push-pull rods, or linkage from the surface to the boost packages, the report said. All damage was found to be the result of impact forces.

The left aileron was in the neutral position at the time of left wing impact, according to the report. The right aileron was displaced downward one-third of its travel by the time the right wing struck. The elevator and rudder surfaces were undamaged prior to salvage but their positions at impact were undeterminable.

"There was no evidence of any structural failure prior to impact with the water," the report said. "There is evidence of a foreign object strike on the air scoop for the No. 1 engine. It consists of a dent about one-half inch deep, four inches wide and seven inches long. A prop cut on the air scoop passes directly through this dent but did not touch the bottom of the crater. It is thus evident that the dent was in the air scoop prior to the prop cut which occurred at impact. The dent contains no metal scrapes and appears to have been made by a non-metallic object. The work of the Structures Group is being continued with documentation of all damage and photographing of all pertinent parts."

All four powerplants have been shipped to the Allison Division of General Motors Corp. at Indianapolis, Ind., and have been torn down and examined, CAB said.

"All gear pieces appeared normal and all damage noted appeared to be the result of impact forces," the Board said. "The No. 1 engine appeared to have been shut down before impact and its propeller feathered. The fuel control was electrically closed, and the No. 1 'panic' handle had been actuated in the cockpit. The Nos. 2, 3, and 4 engines indicated rotational damage to the compressor sections which occurred at impact. The Nos. 2, 3, and 4 propellers

were at blade angles of 38 to 39 deg. of pitch at impact, indicating that all three engines were developing considerable power."

The CAB said inspection of the No. 1 engine indicated that it had been subjected to extreme over-temperature conditions resulting in severe deformation and damage to that engine's combustion section prior to shutdown. The feathers or pieces of feathers found in the air scoop and oil cooler of engines 1 and 4 have been identified as starling feathers.

"A number of samples of foreign matter have been removed from the compressor section, the bleed air valves, fuel nozzles, diffuser section, burner cans, and turbine section of the No. 1 engine," the report said. "The material removed consisted of metal, carbon, marine life, feathers, tissue, and fibers.

"Although all of this material has not been completely identified," the report said, "some of the feather fragments have been identified as starling remains. The tissue and fibers are being further investigated by the laboratory of the FBI and Smithsonian Institute."

The report said similar foreign matter has also been removed from the Nos. 2 and 4 engines and is being analyzed, but that no foreign matter was found in the No. 3 engine. However, feathers were found in the generators of Nos. 1, 3 and 4 engines. The No. 2 engine generator had not yet been disassembled.

The generators were engine-driven and were cooled by ram air tapped from the engine oil cooler scoops and directed into the generators by four-inch-diameter flexible ducts.

Hydraulic boost packages and other aircraft systems components have been taken to Miami, Fla. Flight and engine instruments will be examined in an attempt to determine impact readings, and boost packages will be examined for malfunctioning prior to impact.

The CAB said more than 250 persons who were in the vicinity when the accident occurred have been interviewed and have furnished these details:

"A takeoff was commenced at approximately 5:39 p.m. with liftoff occurring approximately 2,500 ft. from the threshold of Runway 9 which is approximately 7,000 ft. long. The aircraft lifted off in a level attitude and reached an altitude of approximately 30 to 40 ft. It continued at this altitude and in this attitude for several hundred feet, at which time the aircraft rotated to a normal climb attitude and began to climb.

"Some ground witnesses," the report said, "indicated that at this point they observed a puff of smoke from the No. 1 engine, while other witnesses saw a ball of fire from the No. 2 engine. The aircraft then executed a flat left turn to a heading of 045 deg.

"After assuming this heading," the report said, "the aircraft appeared to settle approximately half of the height it obtained to approximately 135 ft. while still in the climb attitude. At this point the nose came up and the left wing dropped to near vertical as in the entry to a wingover.

"During this portion of the maneuver," the CAB said, "the aircraft climbed to an altitude of approximately 350 ft. where the nose fell through rapidly to a near vertical position with the aircraft still rotating to the left. The aircraft crashed into the water slightly left wing first on a south-southwesterly heading."

Wrong Airport

London—Pan American Boeing 707-320 flight from Frankfurt to London landed by mistake at Northholt Airport, several miles south of London, instead of the regular London Airport under weather conditions that reportedly were favorable.

The pilot, Capt. Warren Beall, said the error was due to a close similarity in landmarks and runway arrangement at both airports. His license was revalidated immediately following an investigation by the airline, and no disciplinary action was taken against him.

DC-8 Charges Against Earnings Approach $300 Million Level

Douglas Aircraft Corp. drew near the $300 million mark last week in total DC-8 jet transport charges against earnings when expected declines in development and production costs failed to materialize in the third quarter, forcing an additional $30,519,000 writeoff.

For the nine months ended Aug. 31, Douglas wrote off current and future development charges of $27,210,000 on the DC-8 program and production losses (excess of cost to build over sales price) of $28,347,000. This brings the total program charges to $292 million.

Financial sources in New York were surprised at the new write-off in the third quarter, especially the $14,818,000 inventory write-down on airplanes delivered in the third quarter and future write-down on airplanes to be delivered.

Douglas, which writes down inventory losses against an initial group of individual airplanes (AW May 2, p. 177), had already delivered some "profit" airplanes.

In a letter to stockholders, Douglas explained that problems in developing 18 different airframe engine combinations to meet competitive demands to win customers have been aggravated by engine delivery delays by Pratt & Whitney Aircraft and Rolls-Royce. "An unavoidable consequence of these delays," the letter said, "is disruption of production sequence, so that while certain aircraft already delivered have shown profit in terms of their manufacturing costs, a few among those remaining to be completed will not."

Sales of the DC-8 continue to be slow, the letter added. Negotiation is under way for reorders, which would improve prospects for future profits if they materialize. So would a military order for the DC-8, for which Douglas has been pressing a strong effort.

Douglas' financial statement is:

	Third Quarter	Nine Months
Sales		$858,992,703
Net Loss	$13,099,000	21,868,045
R&D Write-Off	15,701,000	27,210,000
Inventory Write-Down	14,818,000	28,347,000

This third-quarter charge against earnings should make possible a return to profitable operation in the fourth quarter and in 1961, the report said.

Douglas plans to sharpen the DC-8 wing leading edge and extend the entire wing chord 4% (AW Oct. 24, p. 41) and this may account for the future R&D costs written off in the third quarter.

"The DC-8 represents perhaps the largest investment ever made in a single project by one company, without benefit of any government assistance," the letter said. "Its development and manufacturing costs dwarf those of previous transports, and it has faced a competitive situation of unprecedented harshness." Douglas reported continuing orders for cargo conversion of DC-7 aircraft, which now total about 40 and are valued at approximately $15 million. Douglas expects an equal amount of such business in the future.

One compensation for Douglas, and for other commercial jet transport builders who have taken similar recent charges, are tax refunds from prior years that add to cash balances. Douglas estimates a $23,360,000 adjustment due for the nine months of 1960.

Douglas net assets after deduction of the nine-month loss stood at $116,856,312 giving Douglas capital stock a book value of $31 a share. Current price of the stock is $27 a share.

POWER TO FLY...POWER TO PROTECT... by Pratt & Whitney Aircraft. Today the Strategic Air Command's Boeing B-52 bomber has a new profile. Inboard from its J-57 turbojets, two more Pratt & Whitney Aircraft jet engines have been added...a pair of J-52s. These engines power the North American Hound Dog guided missile, designed to deliver a nuclear warhead behind enemy lines at supersonic speed. And for faster take-off, the power of the twin Hound Dogs augments the thrust of the B-52's eight J-57s. Aloft, both the bomber and its Hound Dogs can be refueled from aerial tankers. The application of the J-52 jet engine to the Hound Dog missile is another example of Pratt & Whitney Aircraft's expanded activities in new fields of power.

Pratt & Whitney Aircraft East Hartford, Connecticut / A Divison of United Aircraft Corporation

BAC Pins Production Hopes on VC.10

Weybridge, England—British Aircraft Corp. is pinning its chief hopes for continued aircraft production through 1965 on a family of five second generation jet transports based on the standard VC.10 design now being built for British Overseas Airways Corp.

First of the new transports is scheduled to fly next year and to start coming off the production line in 1963. Sir George Edwards, executive director-aircraft of BAC, told AVIATION WEEK that production is scheduled to coincide with the anticipated next round of major equipment purchases by airlines.

This is the way BAC is planning production of the VC.10 series at the Vickers-Armstrongs plant here:

• **Mockup of standard VC.10** has been completed and fuselage and wing sections are now on the assembly line. British Overseas Airways Corp. has ordered 35 of this model. A long-range aircraft capable of operating over stage lengths of 2,000 naut. mi. from runways as short as 7,000 ft., the VC.10 is designed for BOAC Far East routes where airports are in hot climates or at high altitudes, or are limited in runway length. It will carry a 38,000 lb. payload, for example, on the 4,050 mi. Singapore-Sydney route where takeoffs from 8,000 ft. runways are required. Aircraft will be powered by four Rolls-Royce Conway RCo. 42/2 bypass engines of 20,250 lb. thrust each, now in the development stage. Engines will be rear-mounted on the fuselage.

• **Super VC.10** is a stretched version of the VC.10 and is designed for gateway-to-gateway operations over high density routes such as the North Atlantic for BOAC, which has ordered 10 of the aircraft. Fuselage has been extended 28 ft.—20 ft. of it forward of the wing. Capacity is scaled to 212 economy class passengers (AW Aug. 29, p. 47).

Powerplants will be the Rolls-Royce RCo. 42/2s. Maximum payload will be 58,000 lb., maximum takeoff weight 347,000 lb. and maximum fuel capacity will be 150,000 lb. Super VC.10 will be 186 ft. long.

• **BAC now plans** to make a bid for the U. S. market with a still larger model of the VC.10 which engineers here call the "super-super VC.10." Sir George Edwards said the airplane is still on paper but is being designed to operate over ranges of 4,700 mi. so it can serve nonstop schedules between mid-continent points in the U. S. and mid-continent points in Europe. Fuselage will be increased 9 ft. 8 in. in length. It will accommodate 222 passengers and will have a payload of 53,000 lb. and a maximum takeoff weight of 360,000 lb. The airplane will be powered by four Rolls-Royce Conway Stage 7 bypass engines providing 24,000 lb. sea level static thrust each, also in the developmental stage. Fuel capacity will be 24,000 gal. with the addition of wing tip tanks. Pan American World Airways is reportedly showing considerable interest in the airplane.

• **Chances are now strong** that BAC will launch its VC.11 transport, a scaled-down version of the VC.10 designed for intercity, medium-range routes. Trans-Canada Air Lines and at least one U. S. carrier have indicated an interest in ordering the aircraft if it goes into production. Although these orders would not be sufficient to provide a breakeven factor for the manufacturer, they may be considered adequate to justify the economic risk involved. The VC.11 will be powered by four Rolls-Royce RB. 163 bypass engines of 11,000 lb. thrust each. It will have a maximum payload of 28,500 lb. over a maximum range of 1,700 naut. mi. Capacity will range from 84 to 138 passengers, depending on configuration. Design will be exactly the same as the VC.10 models.

• **Fifth model of the VC.10 family** is the proposed all-cargo, swing-nose version of either all-cargo or super VC.10. Project design work on the airplane has been completed. Both aircraft will be powered by Rolls-Royce 42/3 Conway bypass engines developing 22,500 lb. takeoff thrust each. The VC.10 freighter will have a maximum design payload of 90,000 lb. which can be carried over a 2,850 naut. mi. range with two hours of reserve fuel. The super VC.10 will have a maximum design payload of 98,250 lb., which can be carried over a range of 2,150 naut. mi. with a two-hour fuel reserve. Using Air Transport Assn. cost methods, the VC.10 and super VC.10 freighters will have minimum operating costs of 4.5 and 4.7 cents per ton mile respectively. Nose is opened and closed by a hydraulic jack remotely controlled from the flight deck. Nose is swung on two hinges mounted on the starboard side of the plane, the lower hinge carrying the thrust load and the top hinge the radial loads.

Production Plans

Supplementing the VC.10 series in production plans during the next five years is the BAC 107—a two-engine jet transport designed as a replacement for the Viscount and the Convair 440 (AW Oct. 3, p. 45). Sir George said that sales potential of the aircraft lies in its low operating costs because of the relatively low expense of two powerplants versus three or four engines. The BAC 107 will be powered by two aft-mounted Bristol Siddeley BS-75 ducted fan engines.

Sir George was pessimistic over additional sales of the Vickers Vanguard turboprop transport, which is slated for delivery to Trans-Canada Air Lines in December. He said the airplane was designed to permit operations at low fares, but because delivery of the Vanguards was delayed beyond the summer months of 1960 as a result of turbine trouble in the Rolls-Royce Tyne turboprop engine, the airplane has never had a chance to prove itself in scheduled operations at low fares (AW Oct. 10, p. 52). The Vanguard currently is in production at the Vickers-Armstrongs plant here.

Vickers, now part of the BAC group, is also still producing the Vickers Viscount 810. Sir George said that he expected an "unspectacular dribble" in sales of the aircraft in the foreseeable future and prophesized that operators will find little difficulty in disposing of Viscounts in the used aircraft markets as new re-equipment programs are launched.

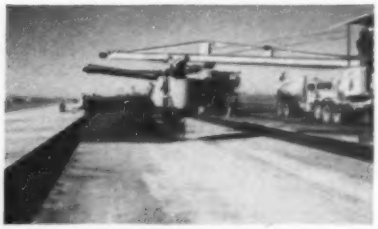
Lead Claimed for VC.10

Sir George feels that the VC.10 series, when available for delivery, will be more advanced in design and performance characteristics than any other long-range transport available in 1963 and 1964 because of lead time BAC has gained by moving second generation aircraft into production now. He added that during the next five years, progressive modifications will be made on the series so that by 1965, the VC.10 may be a completely new airplane compared with its present design.

A strong advocate of the rear-mounted engine principle, Sir George claims that there are many advantageous byproducts of the design in addition to such aerodynamic benefits as creating better high Mach characteristics as a result of a clean wing and allowing use of full span leading edge high-lift devices or uninterrupted trailing edge for high lift at comparatively slow speeds.

He referred to such "byproducts" as reduced cabin noise, no ground-pod clearance problems, better ditching characteristics and basically wide center of gravity range permitting easier load planning. Sir George voiced dissatisfaction with three-engine aircraft on grounds that such a design is too costly for medium-range aircraft in scheduled operations and lacks sufficient power for long-range operations.

At Los Angeles International Airport, old runway resurfaced with CONCRETE makes 150-ton jets feel right at home!



Los Angeles gets ready for jets. Photo shows modern equipment now placing new concrete directly on the old flexible pavement of runway 25L. They're paving 1,600 feet of 25-ft. strips every working day, will take just 120 days for the whole 150-ft. x 6,150-ft. runway! *Artist's sketch at top of page shows how airport will look with modern concrete runways and new futuristic-styled terminal area.*

A 12-inch overlay of concrete provides needed strength to handle the heaviest jet wheel loads ever expected.

Concrete is the only true jet-age pavement. On runways *built specifically for jets*, concrete has been the overwhelming choice.

And in reconstruction, where the old flexible pavement can still serve as a subbase, covering it with minimum-thickness modern concrete gives big savings.

Such overlays are possible because concrete is *not flexible*. The strength is in the concrete itself—and not in built-up, layer construction. Concrete is more than a *smoothing* overlay. It's the one pavement with beam strength that enables engineers to compute loads mathematically, design airport runways for an expected life of *50 years and longer!*

And hot jet blasts can't melt concrete or chew it up. Spilled fuels do no damage, either. Light-colored concrete with its natural grainy surface is the high safety pavement, too. You get better visibility at night and dependable skid resistance whatever the weather.

These are all good reasons, too, why concrete is the preferred pavement for heavy-duty highways—such as those being built for the new Interstate System.

PORTLAND CEMENT ASSOCIATION

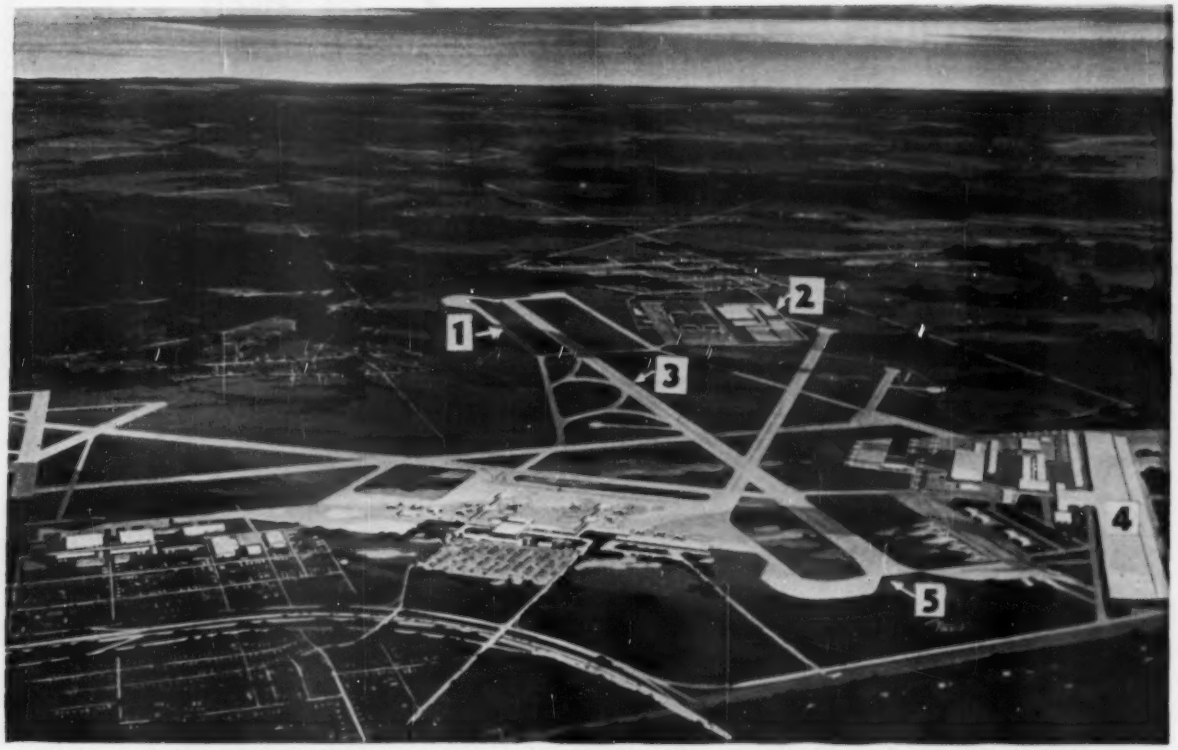
A national organization to improve and extend the uses of concrete

Airline Income & Expenses—August, 1960

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	35,221,916	589,425	406,570	2,103,082	.....	38,841,630	36,316,646	2,524,984
Braniff	6,051,185	170,914	64,988	197,055	137,000	6,726,946	6,127,640	480,002
Capitol	8,334,448	197,533	134,646	152,096	89,509	9,058,891	9,245,012	−186,121[2]
Continental	5,478,000	89,000	44,000	117,000	68,000	5,909,000	4,974,000	778,000
Delta	9,488,000	186,000	125,000	326,000	121,000[4]	10,433,000	10,143,000	108,000
Eastern	20,326,038	429,082	971,097[3]	.....	4,945	21,946,085	22,917,007	−1,353,344
National	4,194,665	95,462	22,418	177,504	138,002	4,725,378	5,630,957	−974,330
Northeast	3,158,107	37,157	20,923	75,001	.....	3,365,562	3,549,011	−183,449[2]
Northwest	7,154,887	208,386	582,712[3]	.....	11,694	8,008,035	7,050,271	796,004
Trans World	24,761,079	481,341	1,295,738[3]	.....	125,363	26,867,297	24,852,890	1,607,544
United	31,557,766	1,031,152	2,214,829[3]	.....	291,062	35,276,296	29,748,836	5,609,782
Western	5,664,066	106,635	190,663[3]	.....	96,773	6,087,992	5,276,377	753,249
INTERNATIONAL								
American	534,526	9,165	149	41,935	.....	616,397	621,688	−5,291
Braniff	908,137	23,395	.....	52,520	.....	1,047,525	1,037,436	−9,277
Caribbean-Atlantic	314,107	2,463	15,936[3]	.....	2,640	339,860	274,272	66,299
Delta	267,000	1,000	.....	6,000	.....	288,000	292,000	−11,000
Eastern	2,782,334	41,400	118,537[3]	.....	.....	2,945,160	2,814,716	79,033
Mackey	182,329	.....	400	2,312	.....	194,672	180,467	14,205[2]
National	119,276	1,308	178	1,630	.....	132,981	136,412	−3,521
Northwest	2,599,966	605,533	394,035[3]	.....	58,235	3,753,698	3,231,508	445,575
Pan American Combined	32,862,000	1,794,000	.....	3,726,000	542,000	40,256,000	36,260,000	3,083,000
Alaska	557,000	16,000	.....	46,000	.....	633,000	488,000	146,000
Atlantic	16,957,000	906,000	.....	1,291,000	297,000	19,895,000	18,336,000	1,558,000
Latin America	7,394,000	190,000	.....	1,087,000	160,000	9,540,000	9,103,000	437,000
Pacific	7,954,000	682,000	.....	1,302,000	85,000	10,188,000	8,334,000	1,877,000
Panagra	1,252,000	50,000	.....	198,000	5,000	1,686,000	1,892,000	−254,000
Resort	.....	.....	.....	.....	8,337[8]	8,337	23,844	−2,926
Trans Caribbean	673,181	.....	27,281[3]	.....	35,712	761,688	683,843	88,278
Trans World	9,125,284	662,921	628,690[3]	.....	466,990	11,219,535	8,334,317	2,764,687
United	3,220,278	92,444	63,698[3]	.....	.....	3,388,191	2,211,762	1,112,201
Western	331,879	5,436	9,845[3]	.....	.....	349,585	371,737	−27,462
LOCAL SERVICE								
Allegheny	1,000,689	10,700	18,553	30,157	613[5]	1,358,731	1,412,731	−54,000[2]
Bonanza[1]	.....	.....	.....	.....	.....	.....	.....	.....
Central	237,653	7,300	2,660	8,903	239	892,194	463,258	428,936[2]
Frontier	650,001	14,800	5,281	29,396	16,982	1,264,035	1,121,224	142,811[2]
Lake Central	247,198	6,257	10,092	.....	65	409,381	395,799	13,582[2]
Mohawk	914,666	12,075	6,203	15,245	34,929	1,168,279	1,206,321	38,042[2]
North Central	1,280,910	31,250	34,146	29,163	8,161[5]	1,924,451	1,845,629	42,685
Ozark	699,658	13,526	13,856	24,255	5,013	1,086,780	1,047,806	38,974[2]
Pacific	627,708	12,725	4,180	5,389	54,654	992,199	946,265	18,329
Piedmont[7]	677,095	10,678	5,821	11,729	14,338[5]	1,070,439	1,023,790	19,827
Southern	217,391	9,209	3,321	6,485	.....	416,656	538,571	127,516
Trans-Texas	433,418	16,173	5,746	20,072	6,800	739,307	722,816	16,128
West Coast	614,994	9,217	4,138	12,716	1,187	2,109,076	992,403	2,077,014
HAWAIIAN LINES								
Aloha	577,982	2,129	.....	6,997	3,842[5]	606,229	521,483	84,746[2]
Hawaiian	712,788	2,635	.....	83,196	118,046[5]	944,573	917,739	26,834[2]
CARGO LINES								
AAXICO[1]	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana[1]	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	.....	10,726	1,127,418[9]	.....	902,905	2,048,460	2,222,877	−194,412
Riddle[1]	.....	.....	.....	.....	.....	.....	.....	.....
Seaboard & Western[1]	.....	.....	.....	.....	.....	.....	.....	.....
Slick[1]	.....	.....	.....	.....	.....	.....	.....	.....
HELICOPTER LINES								
Chicago Helicopter	146,952	135,898	.....	.....	.....	282,933	287,861	−6,297
Los Angeles Airways	26,603	13,549	11,818[6]	.....	400	144,091	121,676	23,434
New York Airways	93,685	4,715	2,367	3,254	.....	303,978	307,999	−6,379
ALASKA LINES								
Alaska Airlines	295,691	60,463	1,367	55,870	264,833	833,222	731,139	91,718
Alaska Coastal	147,355	8,793	.....	12,423	8,761	255,565	200,683	24,882[2]
Cordova	27,050	8,120	.....	14,829	42,067	124,494	117,053	5,334
Ellis	86,079	4,202	8,578[3]	.....	3,093	135,217	127,692	7,525[2]
Northern Consolidated	157,512	45,441	.....	38,633	24,802[5]	330,349	275,815	54,534[2]
Pacific Northern	1,001,640	74,860	2,671	115,550	2,120	1,341,290	1,042,021	291,519
Reeve Aleutian	238,833	43,563	.....	45,650[9]	11,696	342,796	207,253	142,062
Western Alaska[1]	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	211,881	70,039	.....	46,893	100,310	524,443	546,091	−68,352[2]
Avalon Air Transport[1]	.....	.....	.....	.....	.....	.....	.....	.....

[1] Not available. [2] Property figure. [3] Operating income or loss. [4] Other transportation. [5] Non-scheduled transportation.
[6] Express & excess baggage. [7] Airline Division. [8] Incidental income—no operations this month. [9] Freight and excess baggage.
Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.



FACILITIES expansion at Tulsa Municipal Airport includes (1) new taxiway (2) American Airlines overhaul base (3) high speed jet turnoffs (4) Douglas Aircraft plant and (5) instrument landing system runway. West side of field will be devoted to business aircraft.

Tulsa Spending $10 Million on Airport

By Erwin J. Bulban

Tulsa, Okla.—Expansion program totaling nearly $10 million is under way here to modernize terminal and operating facilities at Tulsa Municipal Airport. When completed and in operation in January, 1962, the new construction will increase terminal size nearly six-fold and more than double current gates in addition to improving present runways by providing a taxiway designed for optimum jet transport operation.

In addition to providing increased facilities for airline tenants at the field, the modernization program is expected to be a boon to business plane operators at the airport by giving them additional space.

Construction thus far is some 16% toward completion, in terms of money spent. Steel structure has been erected for the new terminal building, including a ticketing and baggage claim wing and erection of steel for the east concourse will begin immediately, with that for the west concourse going up Oct. 20. Structure to house a new airport surveillance radar is 95% complete and this equipment is expected to begin operating in January.

New terminal building will provide some 180,215 sq. ft. of space, and a new 10,000-sq.-ft. separate air cargo building will be erected adjacent to this structure. The present terminal building, built in 1931 with the last addition made in 1956, contains some 33,000 sq. ft.

It has seven gate positions; the new building will provide 16. The terminal is being designed so that passengers will have a walk of less than 1,000 ft. from the center of the structure to the farthest gate position. Conveyor systems will be able to handle baggage of three airlines simultaneously. Adjacent to the new terminal will be an 800-car parking lot, which will be capable of expansion to 1,000 autos.

Some 1,200 ft. from the terminal, a 50-unit motel will be erected by Airport Parking of America, Inc., with work to start on this facility in 90 days.

A new control tower, approximately 157-ft. tall, will also be erected at the surveillance radar site.

When the new terminal building and control tower are operating, the original terminal building will be made available to business aircraft operations and the airport plans to lease space in the old tower to Federal Aviation Agency for use as maintenance offices.

The new terminal, however, will provide a gate for business aircraft users, as it does now at the present building, to facilitate transfer of executives who wish to connect at the airport with scheduled airlines. But with the new facilities operating, business aircraft operations—there are some 200 business aircraft based at the field—will have the entire west side of the airport for this use.

New taxiway, to parallel the main runway, which has instrument landing system and sequence flashing approach and landing lights, is designed with high-speed turnoffs for jet airliners. Tulsa Municipal expects to have airline jets operating at the field next year. The airport already is the scene of considerable jet activity, since American Airlines has its main overhaul base on one side of the airport and Douglas Aircraft Co. maintains a Boeing B-47 overhaul base on another side.

Considerable expansion in passenger operations is forecast for the field. Last year nearly 425,000 passengers, nearly evenly divided between arrivals and departures, were handled through the field, compared with some 388,000 the previous year. An FAA forecast indicates that by 1965 Tulsa Municipal will be

ARTIST'S conception shows design of new Tulsa airport terminal, now under construction. Layout provides for 16 gate positions.

handling some 944,000 passengers annually.

City financing of the municipal portion of the expansion has been approved by the voters by a 4:1 margin; Federal Aviation Agency has approved an allocation of $3.8 million. Tulsa Municipal fared well in its planning, since it got the project under way in time to take advantage of then-existing federal financing of terminal facilities, which no longer is possible.

The airport is considered a model facility in terms of financing. It has always operated in the black—last year it showed income, over expenses, of $410,000 on a gross of $1,297,000, which was an increase of some 20% over the previous year despite the fact that revenue from fuel sales dropped considerably due to a marked decrease in military transient operations. Sustaining this drop-off was an increase in fuel sales to business aircraft.

Tulsa Municipal operates under the autonomous Tulsa Airport Authority, consisting of four non-political appointees, plus the mayor, and all its revenues are set aside in a separate category and are not available for other uses, airport manager Pat Combs said. The airport has always paid all of its own operating expenses, employe salaries and capital expenditures and does not build the fund, but continually plows it back into airport improvement. Landing fees are not charged transient aircraft.

It retains the fuel concession, the airport's biggest money maker, rather than bid it out to one of the operators and then collect fees. Airlines, however, do handle their own fueling operation.

The authority has strong backing because the city is decidedly airminded. Indication of this is shown in its attention to the business flyer. In 1958 the Authority established a separate airport facility, Riverside Airport, to overcome the growing lack of private fields due to real estate development. Riverside Airport, which now has some 88 business and private aircraft based there, has operated in the black for a net of about $1,000 per month since the second month of its start. The city has an investment of approximately $1.5 million in this field.

Ethiopians Plan Trans-African Link

Cannes, France—Ethiopian Airlines is rushing plans to inaugurate a trans-African air service which will directly link for the first time East and West Africa.

Ethiopian Airlines officials, meeting at Cannes, said the first flight has been set for Nov. 8. Route will hook up Addis Ababa, the Ethiopian capital, with West African points in Nigeria, Ghana and Liberia. Thus, for the first time, travelers will be able to cross Africa directly. Presently, air travelers on Africa's West Coast reach African East Coast points via Western Europe. Airline, which for years has been largely operated by Trans World Airlines under a management contract with the Ethiopian government, plans to use Douglas DC-6Bs.

Flight would leave Addis Ababa on Tuesday for Khartoum, Sudan. Next leg—some 2,000 mi.—tracks across Africa to Lagos, Nigeria, on the West African coast. At the moment, bilateral discussions are still going on between Ethiopian and Nigerian governments over passenger rights. It is expected an agreement will be reached by Nov. 8. If not, then Lagos will be used as technical stop.

After Lagos, next regular planned stop will be Accra, capital of Ghana. Flight will terminate at Roberts Field, near Monrovia, capital of Liberia.

Ethiopian government is interested in the new route for political reasons, as well as commercial. With more and more of the East and West African nations becoming independent, there is a natural desire for Ethiopia, one of Africa's oldest national states, to communicate with its new neighbors. Addis Ababa government, for example, used its national airline to play an important transportation role in the Congo affair.

In addition to such political motives, Ethiopian airline officials are anxious to pioneer a route which they consider has great traffic potential. There is a good deal of traffic, for example, between the Middle East and West Africa. With its new route, Ethiopian Airlines expects to provide this market with the most direct air route between the Middle East and West Africa.

Moreover, Addis Ababa is becoming the center for United Nations' technical aid to the whole of Africa. This single activity is expected to generate considerable trans-African traffic over the next few years.

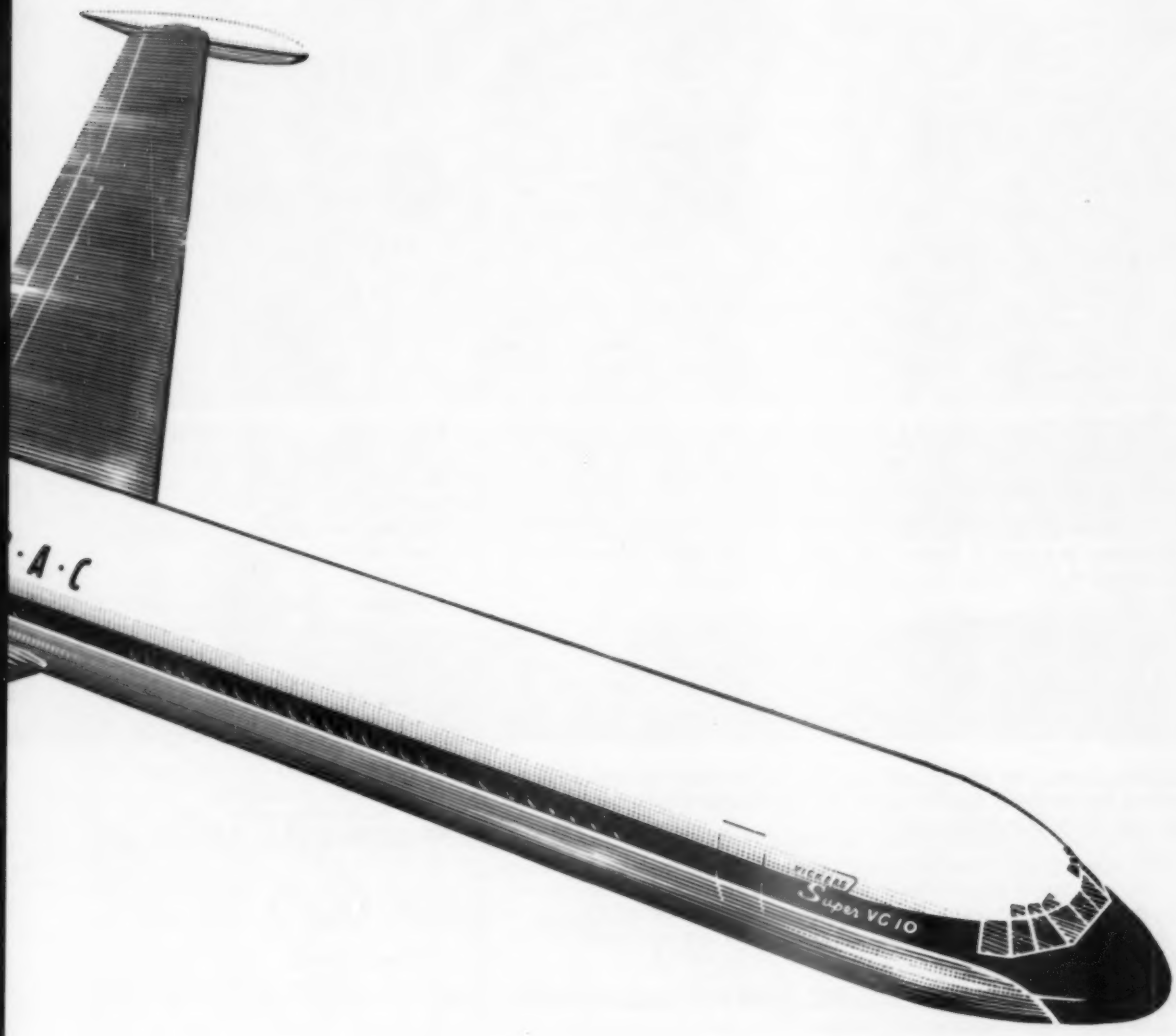
BOAC ORDERS 10 VICKERS SUPER VC 10's

BOAC has followed its contract for 35 Vickers VC 10 jetliners by ordering from British Aircraft Corporation ten Super VC 10's—aircraft which are tailor made for high density routes such as the North Atlantic.

In an economy class layout the Super VC 10 can carry up to 212 passengers plus 4 tons of freight non-stop from London to New York against strong headwinds.

Both Vickers VC 10 and Super VC 10 with their new look clean wings and rear-mounted engines will offer an air field performance and a cabin comfort which will make them the most passenger preferred long haul jets in operation.

FROM BRITISH AIRCRAFT CORPORATION!



VICKERS
Super VC 10

POWERED BY FOUR REAR-MOUNTED ROLLS-ROYCE CONWAY BY-PASS ENGINES
MEMBER COMPANY OF BRITISH AIRCRAFT CORPORATION

AIRLINE OBSERVER

► American Airlines officials are discussing the Caravelle Mark VII transport, powered by General Electric CJ805-23 aft fan engines (AW Aug. 8, p. 53), with Sud Aviation in France. Fleet of 40 is under consideration. Carrier is currently specifically interested in a twin-engine transport for its medium-range jet requirement. The Convair 60 is a strong contender (AW Aug. 1, p. 40).

► Although Russia officially denied grounding its Il-18 turboprop transport (AW Oct. 10, p. 37) the behavior of the Soviet press, coupled with reports from U.S. observers in Russia, gave ample evidence that the aircraft had run into trouble. Until about Sept. 1, Il-18s were specifically mentioned whenever they carried important persons into or out of Moscow. A complete blackout on Il-18 references then began and continued until mid-October. At that time, Soviet newspapers broke the silence by reporting that Hungarian Premier Janos Kadar flew home from Moscow in an Il-18 and that another special Il-18 flight carried Russian doctors and medicine to Kabul, Afghanistan, to combat a cholera outbreak—indicating the transport was back in service (AW Oct. 24, p. 39).

► Negotiations between the U.S. and India on amendments to the bilateral air transport pact have been broken off because of India's refusal to accede to U.S. demands that capacity and flight frequency restrictions enforced against U.S. flag carriers be lifted. U.S. sought an increase in the number of allowable flights into India from six to 10 weekly, but the Indians held that they could not revise their policy of traffic control because agreements with other countries contain similar restrictions. Meanwhile, chances are strong that India will be granted permission to add Moscow as an intermediate stop on Air-India's U.S.-India route.

► Federal Aviation Agency has invited Britain, Canada, Ireland and Portugal to participate in a project designed to determine air traffic control capacity requirements on the North Atlantic for the 1965-70 period.

► Flight Engineers International Assn. President Ron Brown has charged that flight crew unemployment caused by airline introduction of jet equipment is running ahead of expectations. He said the number of men the union expected to lose through furlough during the entire period of transition to jets already have lost their jobs at the halfway point of the jet changeover.

► Supersonic transport aircraft will head the list of items scheduled on the agenda of International Air Transport Assn. Technical Conference slated to begin Apr. 17 in Montreal.

► Braniff Airways will reduce its tourist fares on U.S.-Latin American routes 35% effective Apr. 1 in accordance with agreement reached in the International Air Transport Assn. traffic conferences at Cannes (AW Oct. 24, p. 41). First class fares will be increased up to 10%. Fares are subject to government approval.

► Ozark Air Lines has received stockholder approval to increase authorized common stock from 2 million to 4 million shares and to convert three outstanding classes of stock into one new class of common. New certificates for Class A and B stock and general common stock will be issued on a one-for-one basis.

► Allegheny Airlines is now operating four of the five Convair 540 turboprop transports it has on order. The carrier reported to the Civil Aeronautics Board that the fleet will achieve total direct operating costs of 95.36 cents per revenue mile—or 1.8 cents per available seat mile—in regular service. Napier Engines, Inc., is now maintaining a spare engine pool and parts supply in Washington for the Eland engine which powers the Convair 540. Plans call for an expansion of parts and overhaul facilities in other U.S. areas.

► United Air Lines is debating between a convertible preferred stock or a convertible bond issue to finance its order for the Boeing 727, assuming Boeing decides to build the aircraft. Some form of equity financing appears to be necessary in a market looking none too robust.

SHORTLINES

► **British Overseas Airways Corp.** reports it carried 626,000 passengers on its world-wide routes during the fiscal year ending Mar. 31, 1960, an increase of 26% over the previous fiscal year. Load ton-miles—passengers and cargo—rose 29% to 290 million. BOAC aircraft flew 176,824 hr. and 53.6 million mi. The carrier has announced it will begin transatlantic all-cargo service next month in converted Douglas DC-7C aircraft with a payload capacity of 32,000 lb. Two of BOAC's DC-7Cs are now being converted at the Douglas Aircraft Co. Santa Monica plant to DC-7F cargo configuration.

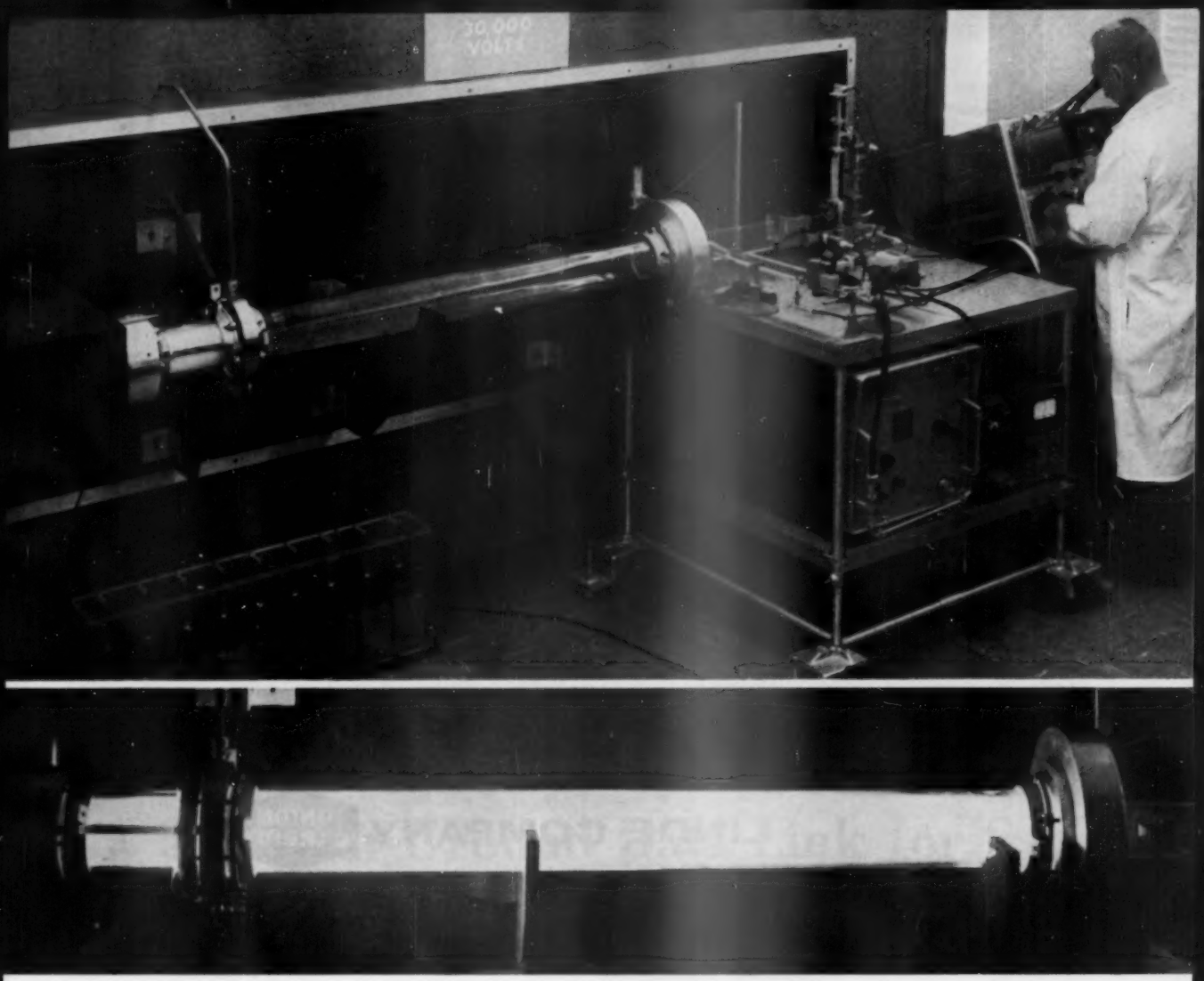
► **Delta Air Lines** was scheduled to begin daily Convair 880 first class service Oct. 30 from Friendship International Airport, which serves Washington and Baltimore, to New Orleans and Houston. The new service will originate and terminate in Philadelphia.

► **Eastern Air Lines'** new Douglas DC-8 service between Boston and Miami was scheduled to begin Oct. 30. Service will begin with a daily first class flight via Philadelphia and four nonstop night coach flights a week.

► **Federal Aviation Agency** will begin using a new type of written examination for all applicants for Airline Transport Ratings in November. The new examination consists of problems normally encountered in flight planning, interpretation of weather data, navigation, use of radio aids and application of Civil Air Regulations. Applicants who have successfully completed one or more parts of the old sectional examination will be permitted to take the sections which they failed again if they apply before July 1, 1961.

► **Sabena Belgian World Airlines** has started modifying its Pratt & Whitney JT4A turbojet engines to increase their thrust 1,700 lb. in order to enable the Sabena fleet of Boeing 707 Intercontinentals to take off with increased payloads at airports where runways are not long enough to permit takeoff now with a full load.

► **Trans-Canada Air Lines** has signed a reciprocal agreement with the Hungarian state airline, Malev, under which both carriers will book passengers on the other carrier when passengers originate in their countries. Hungary is the fourth East European nation to reach agreement with TCA—the other three are Poland, Czechoslovakia and Yugoslavia.



PLASMA AND PROPAGATION Electromagnetic attenuation as a function of frequency, and magnetic window techniques to alleviate the propagation problems, have been predicted and verified with the Bendix electrically-excited shock tube. These are the keys to future communication with hypervelocity vehicles. Career positions are open in both theoretical and experimental plasma physics, and communications.

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With a capacity of 13,000 lbs./day, the new LINDE liquid hydrogen plant at Torrance, Calif., is prepared to meet current requirements. This important liquid fuel is available in tonnage or liter quantities, for operations or research.

The new LINDE plant is the first privately-owned large liquid hydrogen plant in existence. Designed, constructed, and operated by LINDE engineers, financed by LINDE capital, and implemented by LINDE delivery and storage facilities, it marks a long step forward in liquid hydrogen supply.

The product delivered from this new plant contains less than two parts per million in impurities. It is suitable for all purposes including fuel, laboratory experimentation, or engine testing. Distribution in tank trailers and containers insulated with LINDE super-insulation keeps losses remarkably low.

For additional information on this new LINDE facility and its products, write Linde Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada,* Union Carbide Canada Limited, Linde Gases Division, Toronto 12.

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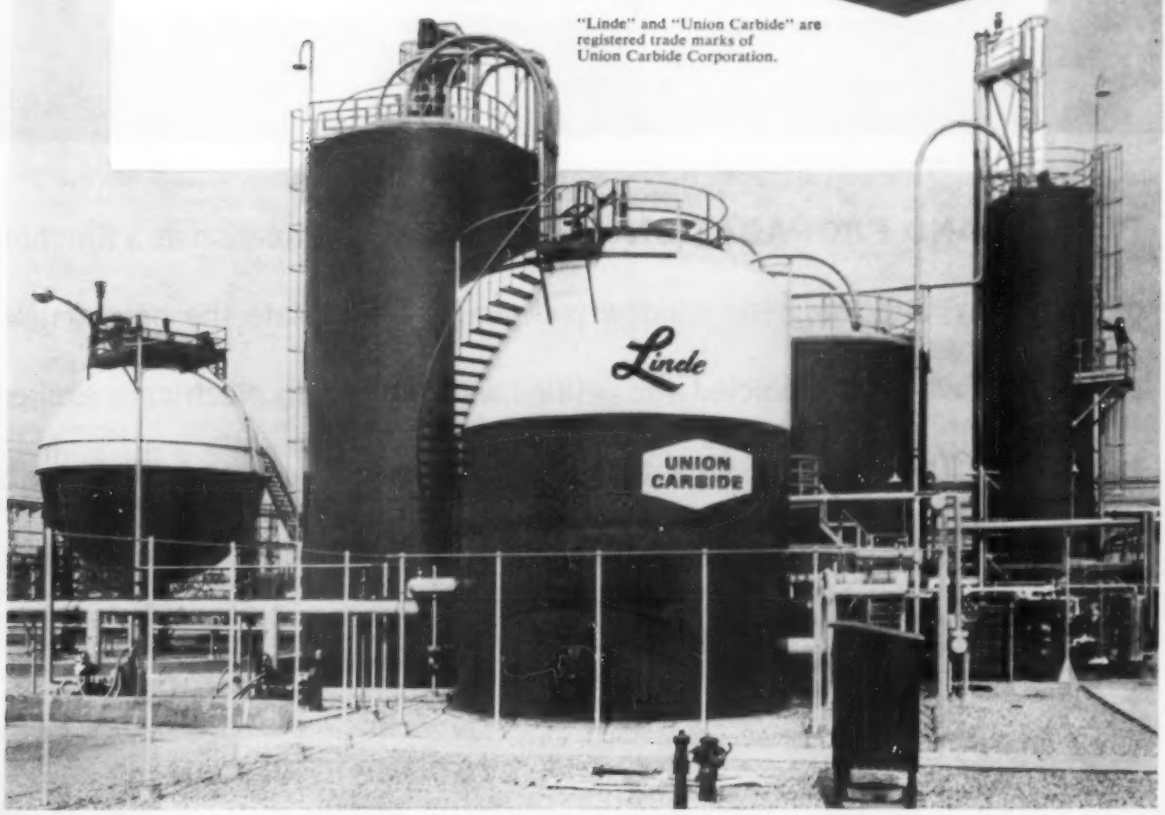
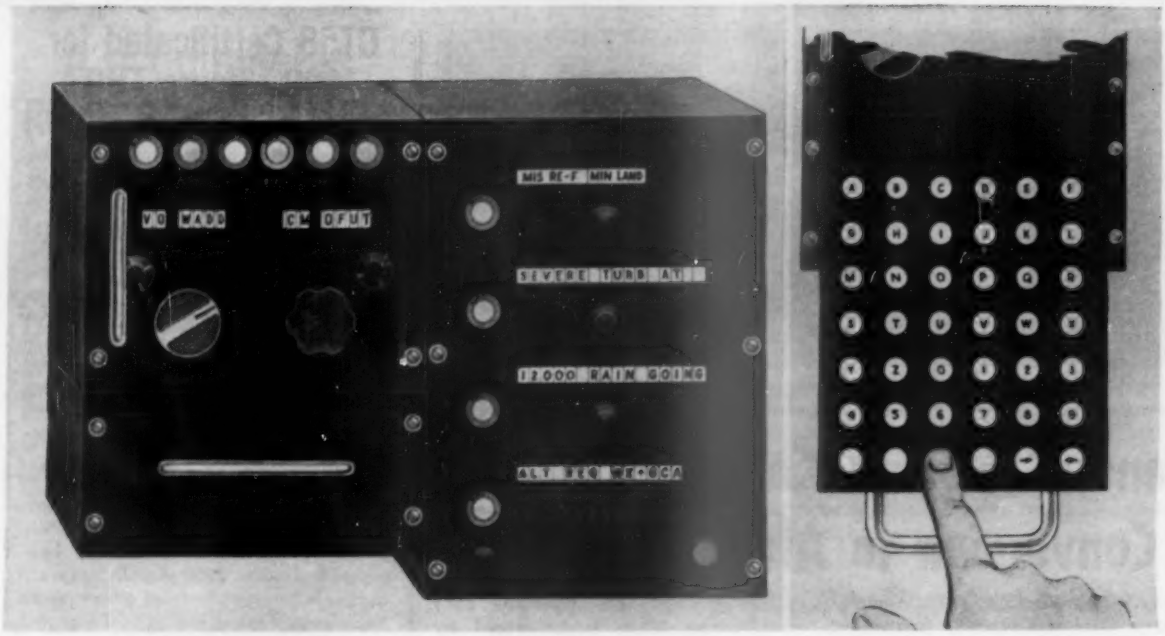




DATA LINK for SAC bombers and tankers is expected to provide fast, secure ground-air communications. System developed by General Electric, is called Discom. In cockpit pilot has selective calling console (left) and message display (center) whose top row displays "canned" messages while three lower rows display flexible format messages. To send message from aircraft to ground, pilot would use pushbutton composer (right) located in withdrawable panel underneath left console.

GE Tests Air-Ground Data Link for SAC

By Philip J. Klass

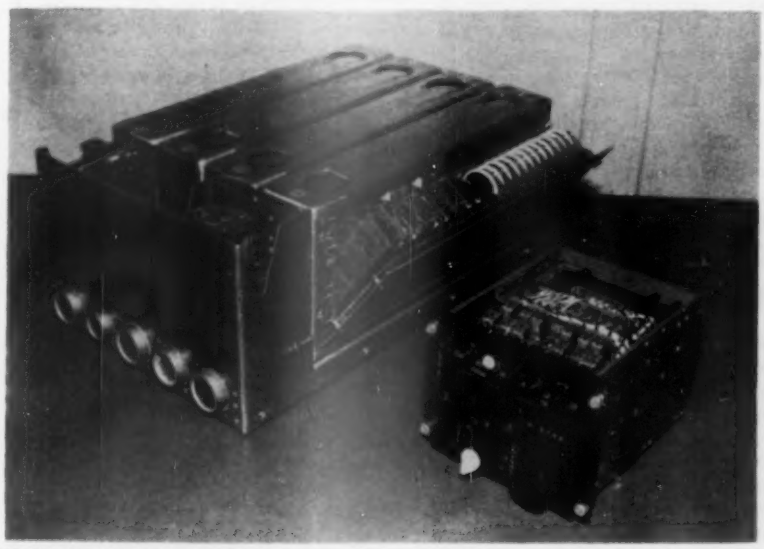
Lynchburg, Va.—A digital communication system, intended to improve the speed and security of Strategic Air Command's ground-air communications with its far-flung bombers and tankers, began its evaluation tests here this month. System was developed by General Electric's Communication Products Department here.

Using the new data link, a SAC command post will be able to transmit messages in digital form over existing Short Order single sideband radio stations which will be displayed in the cockpit of a specific airplane, group of aircraft or in the cockpits of all SAC aircraft, as desired.

The digital communication messages are expected to get through under adverse propagation conditions, either man-made or natural, which might interrupt presently-used voice communications, according to George Scheer, Wright Air Development Division's Communications Laboratory.

An equally important gain from digital communications is expected when SAC gets its new automatic control system (465-L) using large ground-based digital computer installations (AW June 20, p. 133). Digital communications system, tied into aircraft navigation and altimetry equipment, will enable SAC Control System computers to interrogate aircraft and determine their position and status without human action or intervention in the aircraft or on the ground.

The new two-way SAC data link, called Digital Selective Communica-



SELECTIVE CALLING UNIT, a portion of complete Discom system, weighs about 25 lb. including control console (right), but in production size and weight should be less. GE will soon begin evaluation tests with airborne tests slated for next summer.

Flight Propulsion

General Electric's Caravelle is currently being converted to CJ-805-23 aft-fan engines at Edwards AFB, California. Production aircraft have been designated Caravelle VII.

General Electric Caravelle Begins Conversion to Aft-fan Engines

EDWARDS AFB, Calif.—The General Electric Caravelle recently arrived at the Flight Test Center here to begin conversion to CJ-805-23 aft-fan power preparatory to flight testing. The program calls for retrofitting this fall, with first flights scheduled for December.

The G-E Caravelle arrived after carrying over 3000 passengers during a 16-city sales tour conducted by Douglas Aircraft Company. Douglas will sell and service the Caravelle in the United States and several foreign countries.

The first two CJ-805-23 engines assigned to the Caravelle program are on hand awaiting installation, with the number one engine heavily instrumented. CJ-805-23-powered production aircraft have been designated the Caravelle VII by Sud Aviation.

Each of the CJ-805-23 engines will produce 16,100 pounds static thrust to boost Caravelle speed and range. The new powerplants will also permit reduced sound levels and shorter take-offs and landings.

The aircraft's distinctive short-cowl nacelles are being manufactured by Douglas at Santa Monica, California. Engines will be mounted in the aft-fuselage position. Aft-engine placement and the -23's low inherent noise level will minimize cabin sound in the Caravelle VII.

Based on recently completed flight tests on the CJ-805-23 engine, the Caravelle VII will have extremely low noise levels. Two and a half miles from take-off roll, or at about 1300 feet altitude, the noise level is 106.5 PNdb at full take-off power. During approach at maximum landing weight, the noise level is 108 PNdb at 400 feet altitude.

General Electric's Caravelle short/medium range jet airliner program, announced last December, is designed to make the aft-fan Caravelle VII available to the world market early in 1962.
For further information on the Caravelle VII/CJ-805-23, check GED-4176. See coupon.

CF700 Completes Two 150-hour Runs

LYNN, Mass.—General Electric's CF-700 aft-turbofan engine recently completed its second unofficial 150-hour endurance run in less than a month.

On both occasions, the powerplant bettered guaranteed thrust and specific fuel consumption. Guaranteed sfc for the 4000-pound-thrust engine is 0.69 lb/hr/lb.

The CF700, destined for the corporate aircraft market, has endurance capabilities which stem from the J85 military turbojet with its more than 17,000 hours experience and the FAA-certified CJ-805-23 aft turbofan commercial engine. The CF700 gas generator is virtually identical to the J85, while the CF700 fan component is a scaled-down version of the CJ-805-23 fan package.

Initial testing of the CF700 began in mid-May. Throughout the test program, acceleration time from idle to full thrust remained below five seconds.

Flight test engines are scheduled for availability in early 1961; FAA-certified engines a year later.
For more information about the CF-700 check GED-4194 and GED-3986. See coupon.

CT58 Certificated for 1000 Hours TBO

LYNN, Mass.—General Electric's CT-58 turbocopter engine recently became the first helicopter powerplant to be certificated for commercial operation with Federal Aviation Agency approval for 1000-hour time between overhaul.

The 1000-hour rating, representing more than a year of normal operation, is the longest TBO granted by the FAA for either reciprocating or turbine helicopter engines. The new rating applies specifically to the Sikorsky S-62, which recently became the first American turbocopter to be certificated for commercial operation.

The T58-6, military counterpart of the CT58, passed its qualification test in August 1958. The T58 recently powered a bailed Navy HSS-1F helicopter more than 1000 flight hours without overhaul, operating about three hours a day for a full year. Parts and components were well within wear limits.

The CT58 and T58 engines power a broad range of modern commercial and military aircraft.
For additional information on the T58 turboshaft engine check GED-3987A. See coupon.

CT58 powers the Sikorsky S-62, first American turbocopter certificated for commercial operation.

Nuclear Flight Propulsion Group Joins FPD

In a move to align operating groups more closely with customer needs, General Electric's Aircraft Nuclear Propulsion Department has been assigned to the Flight Propulsion Division. General Manager is David F. Shaw, who reports directly to John B. Montgomery, newly-appointed division vice-president.

ANPD has been engaged in the development of a military nuclear aircraft propulsion system since 1951. Successful ground tests of reactor and engines have been achieved since 1956 on a direct air cycle system.
For information on approaches to aircraft nuclear propulsion, check GER-1544. See coupon.

NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company

A3J Completes First Carrier Trials

EVENDALE, O.—The Navy's North American Aviation A3J Vigilante, powered by two General Electric J79 engines, recently completed the first phase of its carrier suitability trials.

The week-long tests were conducted aboard the USS *Saratoga* off Mayport, Fla. The Vigilante made 15 catapult launches and 14 arrested landings during its first carrier demonstration. Pilots tested the Vigilante's powerplants with several "touch and go" landings, and the plane was given general carrier suitability checkouts, including towing and spotting.

A3J catapults from the USS *Saratoga*, powered by two G-E J79 engines.

The sleek Mach 2 bomber's J79 engines have the highest thrust-to-weight ratio in their class and provide low specific fuel consumption. The J79 produces more than 16,000 pounds of thrust, yet weighs only about 3600 pounds.

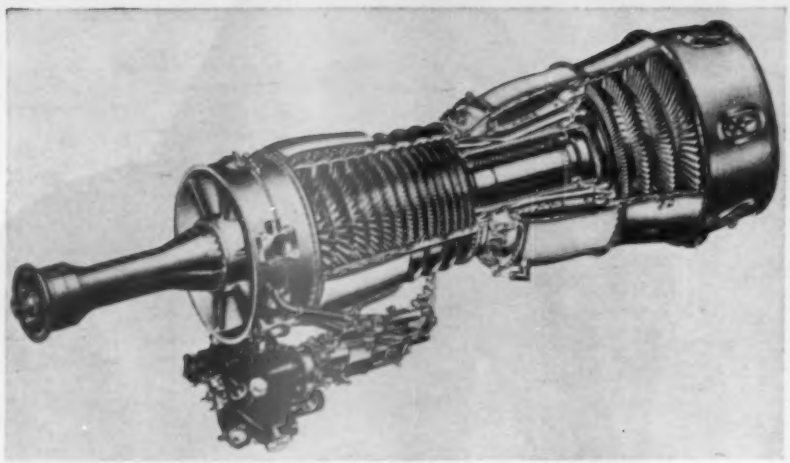
B-58 CREW WINS SAC BOMBING TROPHY

BERGSTROM AFB, Tex.—The J79-powered Convair B-58 Hustler, first U.S. Mach 2 bomber, recently demonstrated outstanding capability in its first SAC combat competition.

In the bombing competition, top individual score was recorded by Major Harold Confer and his crew from the B-58 equipped 43rd Bomb Wing. The Wing, which had flown the B-58 only six weeks, placed second in unit bombing and fifth in over-all competition for the Fairchild Trophy, won by B-52's of the 11th Bomb Wing.

The unit bombing competition was also won by 11th Bomb Wing, while J47-powered B-47's of the 340th Bomb Wing took the navigation award.

Aided by the B-58's ability to start its J79 powerplants while taxiing after cart-start of the number one engine, the Hustler crew swept the ground alert timing competition.



Cutaway view of General Electric's T64 turboshaft configuration, which exceeded all guaranteed specifications in preliminary flight rating test.

T64 Turboshaft Engine Exceeds Pre-flight Rating Test Guarantees

LYNN, Mass.—General Electric's T64 turboshaft engine recently passed its official preliminary flight rating test (PFRT), exceeding all guaranteed specifications.

G-E's Small Aircraft Engine Department, with Navy concurrence, ran three official tests on this version of the T64 gas turbine, two on JP-4 and one on JP-5 fuel. In each test all performance parameters, including acceleration times, oil consumption, starting time and deterioration were well within specification limits.

The engine developed 2780 shaft horsepower at military rating with a specific fuel consumption of 0.490 lb/-hp-hr, as compared to its performance guarantee of 2650 shp and 0.506 sfc.

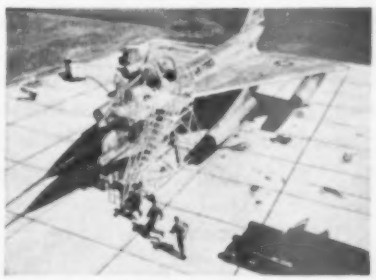
Test approval of the T64-2 turboshaft automatically qualified the powerplant's direct drive version, the T64-6, for flight testing.

The T64-4 and T64-8, turboprop models of the engine, are also expected to receive official PFRT approval later this year.

All models utilize an identical power unit and differ only in reduction gearing and accessories. Under development for the Navy, the T64 is designed for large helicopters, fixed wing and VTOL, STOL applications.

For more T64 information, check GED-4094. See coupon.

FOR MORE DETAILED INFORMATION on these and other developments in General Electric products, contact your nearest G.E. Flight Propulsion Division representative or indicate below the free brochures you would like to receive.



Alert sends crew hustling to B-58.

Major Confer's winning time was two minutes, twenty-five seconds from klaxon to taxi.

General Electric Company
Section A206-17
Schenectady 5, N. Y.

- ☐ GED-3986 and 4194 "CF700-1 Turbofan"
- ☐ GED-3987A "CT58 Engine"
- ☐ GED-4106 "F4H/J79"
- ☐ GED-4176 "Caravelle VII"
- ☐ GER-1544 "Approaches to Aircraft Nuclear Propulsion"
- ☐ GED-4094 "T64"

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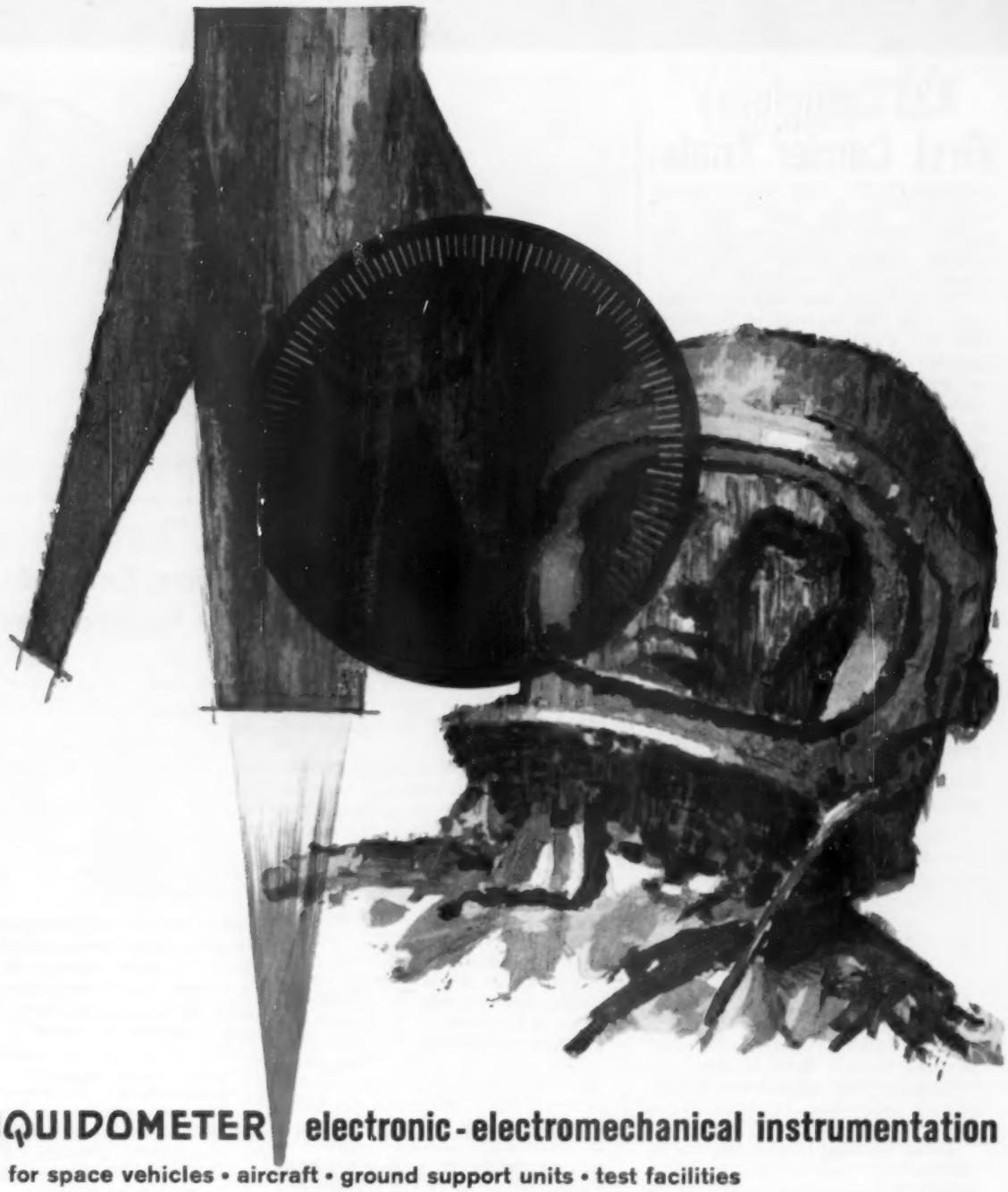

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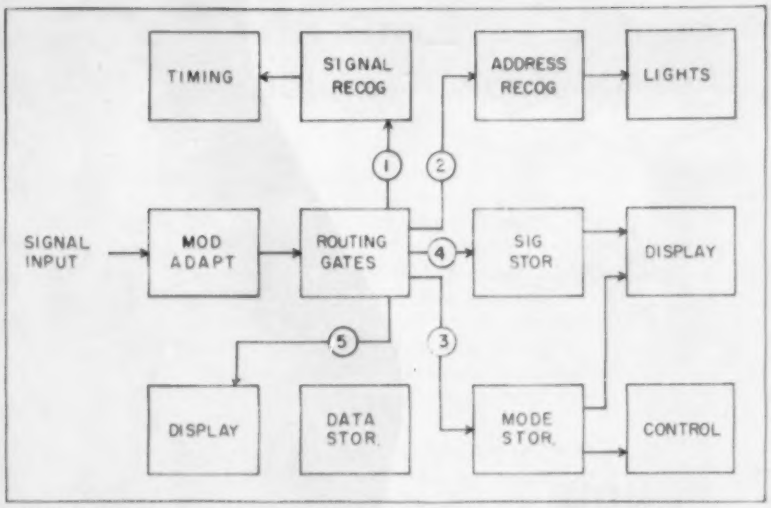

SEQUENCE of Discom signal-message flow and analysis in receive mode is shown.

tions, or Discom for short, will provide the following services:

- **"Canned" messages,** consisting of 36 (or more) commonly used commands, instructions or replies.
- **Flexible format messages,** containing up to 48 alpha-numeric characters for special communication situations where canned messages are not suitable.
- **Request for voice contact,** showing specific base that aircraft should contact.
- **Automatic switching functions** which enable a ground station to activate, deactivate or interrogate certain equipments aboard the aircraft or change its operating mode, such as IFF (identification friend or foe). This service ultimately will be used to obtain automatic altitude and position reports from aircraft navigation equipment.

The GE system enables individual bomber/tanker crews to also transmit canned or flexible format messages in digital form to any selected ground station(s).

The GE Discom system has several characteristics, such as flexible format message structure and moderate-speed data rate (50 bits per second), which could make it attractive for civil use. Several months ago the Air Transport Assn., in a statement expressing airline views on civil data link needs, criticized the AGACS data link being developed by Radio Corporation of America under Federal Aviation Agency sponsorship because it lacked flexible message capability and operated at an extremely high data rate (AW June 20, p. 86).

Prototype Airborne System

The prototype airborne Discom system which GE has constructed for evaluation tests weighs approximately 60 lb. Because equipment was developed on an extremely short timetable of about one year, it does not represent the ultimate in miniaturization. A production redesign should permit the airborne system weight to be cut to about 35 lb., according to G. A. Kious, Discom project manager. The system is completely transistorized, Kious reports.

Discom Fundamentals

For maximum flexibility in application and use, the Discom system has been designed in the form of two basic subsystems:

- **Selective calling,** called control monitor group (AN/URA-22) which enables ground station to alert individual, group or all aircraft and transmit up to 676 discrete messages or switching commands.
- **Digital message unit,** called digital data group (AN/URA-29), which can be added to selective calling subsystem to provide for two-way digital communication of both canned and flexible format messages.

In the prototype equipment, the airborne selective calling unit and its associated cockpit control/display console weigh about 25 lb. The digital message unit and its cockpit message composer/display weigh about 33 lb., according to Kious.

Selective calling, from ground to air or vice versa, is accomplished by transmitting a series of four call letters which correspond to the specific code assigned an individual aircraft, group or the entire fleet. The four letters assigned can be a phonetic expression of the station identity, similar to technique used in airline baggage tags, or completely arbitrary. For example, code letters for SAC Headquarters might be OFUT, or AGTV.

When ground station transmits a call to an individual aircraft, group of aircraft or the entire fleet, the cockpit display of aircraft being called will start flashing. The particular lamp illuminated will indicate whether the call is

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Engineers and scientists experienced in these or related fields will find it rewarding to discuss their career futures with Marquardt. The company's growth is a parallel to the atmosphere of challenge and rewarding accomplishment that has existed since the firm's beginning.

SPIN FORGE (TOP) — Capable of exerting an accurately controlled million pounds working force, this Spin Forge cold-flow forms seamless components up to 5 feet in diameter and 15 feet long.

40 KW PLASMA JET (CENTER) — Temperatures up to 30,000°F generated by plasma flame may be used for applying ceramic, metal or cermet coatings.

TM-1 TEST MACHINE (BOTTOM) — The auto-dynamic elevated temperature testing machine conducts tensile, creep, stress-rupture, compression tests of metals at temperatures up to 3,500°F. Programming of mission load-temperature-time parameter may be performed.

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CORPORATE OFFICES: VAN NUYS, CALIFORNIA

individual, group or a general broadcast. When the pilot pushes the flashing light, causing it to go out, Discom transmits an acknowledgement signal containing aircraft identity code back to the ground station.

Immediately thereafter the "From" window on the panel will display six letters, two of which represent one of 676 possible discrete messages, while the remaining four letters identify the ground station calling. The letters are displayed by means of six individual rotating drums, one for each letter. For calls from ground station, the "To" window would be blank.

If an aircraft wants to send a selective call to a specific ground station, the pilot uses the two insert knobs to set up the desired two-letter message code and the station identity code in the right-hand (To) window. He then selects the radio channel on which he wants to transmit and finally pushes the transmit button. Discom can transmit on single sideband, normal high frequency (AM), or ultra-high-frequency.

The identity of the calling aircraft, and its two-letter coded message, will then appear on a display console of the ground station. When the ground station operator acknowledges the call, the "Ackn" light on the airplane console will flash.

Digital Unit

Although the selective calling unit's two-letter mode code permits transmission of up to 676 prearranged codes (26 x 26), it requires the use of a code book which is an operational inconvenience. With the addition of the digital message unit and its display/composing console, the system gains in flexibility and speed, but at the expense of added equipment weight and complexity.

The digital message console displays both canned and flexible format type messages received from the ground and also is used for composing messages sent from the aircraft to the ground.

Behind the top display slot are three drums, each with 36 positions around its periphery upon which one or several frequently-used words are printed. To select any one of these 36 positions on the first drum, and its word display, it is necessary only for the ground station to transmit a single alpha-numeric character, immediately following its six-letter selective calling code transmission. (The 26 different letters plus 10 different numbers provide for the 36 different drum positions.)

Rapid Transmission

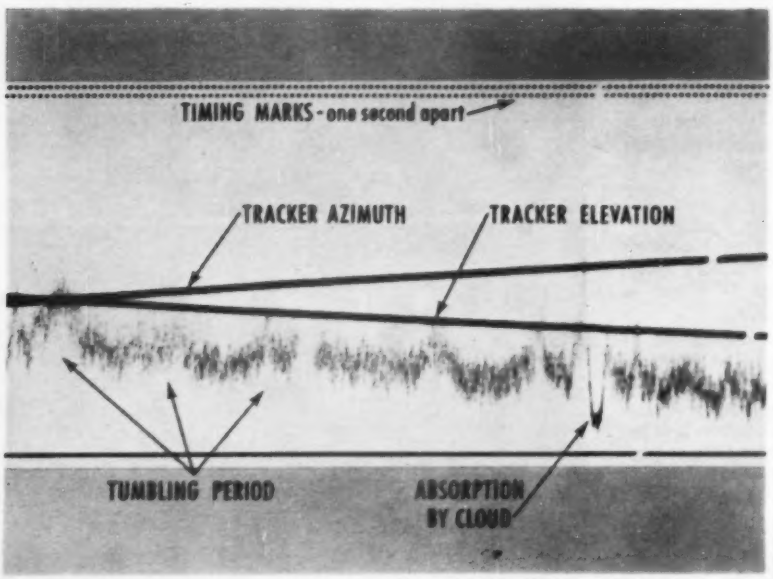
By transmitting a series of three alpha-numeric characters, the ground station can position each of the three drums to display one of the canned messages. The entire canned message requires only about one-half second to transmit, in addition to the several seconds required for the initial selective call.

The next three horizontal slots on the console are used to display flexible format messages. Behind each of the three slots are 16 individual rotatable drums, each with 26 letters and 10 numerals around its periphery.

By transmitting additional alpha-numeric letters (or spaces), tracked onto the selective call, the ground station can position each of the drums in sequence

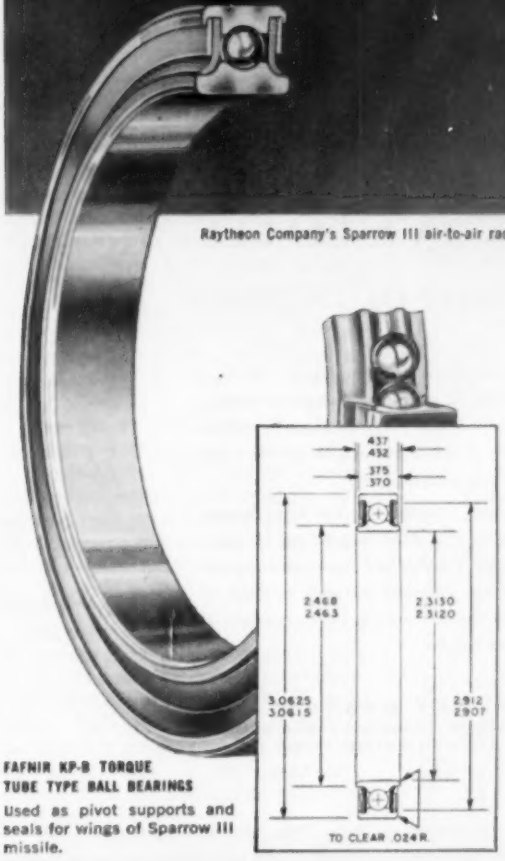
Tracker to Obtain Satellite Tumbling Data

Lightweight tracker developed by Raytheon Co. will be used to obtain data on satellite tumbling so that this characteristic can be counteracted in design of manned spacecraft and communications satellites. Electrical-optical unit uses 6-in. mirror to collect light reflections. Changes in light intensities indicate tumbling. Echo signature (below) was reproduced from type of Raytheon Co.'s new satellite tracker. Because tracker and equipment can be installed in 8-cu.-ft. size, the system can be carried in aircraft for observations above cloud cover.



SPARROW III "flies home" on FAFNIR BALL BEARINGS!

Raytheon Company's Sparrow III air-to-air radar homing missile, fired from Navy interceptor, can track and destroy target on its own.



FAFNIR KP-B TORQUE TUBE TYPE BALL BEARINGS
Used as pivot supports and seals for wings of Sparrow III missile.

Fafnir Torque Tube Type Ball Bearings less than ½" thick and weighing only 4 ounces each, support the wing pivots in Raytheon's Sparrow III missile.

To carry loads imposed by wing operation at Mach 2+, each of these Fafnir bearings is fitted with its maximum complement of 45 balls. The bearings also have tight, integral seals of extra-thick Buna N material to withstand the pressures of supersonic flight. These seals provide positive protection against atmospheric contaminants and loss of factory-packed bearing lubricant.

Fafnir's experience with bearings for missiles, jet engines, and aircraft controls and accessories is unmatched in the industry. Take advantage of it. Look to Fafnir for a *sure* approach to your bearing requirements. Write The Fafnir Bearing Company, New Britain, Conn.

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BALL BEARINGS

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Avnet Service Centers and Stocking Facilities are located in Los Angeles, Cal.; Sunnyvale, Cal.; Chicago, Ill.; Dayton, Ohio; Westbury, L. I.; Burlington, Mass.

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to spell out any flexible format message with up to 48 alpha-numeric characters.

For composing a canned or flexible format message for transmission from the aircraft to the ground, a small push-button keyboard is pulled out from under the selective calling control console. By pushing the appropriate buttons, the pilot can frame any message, which will be displayed on the digital message console. When a message is completely composed the pilot pushes the transmit button.

If an incoming message is received by the aircraft while the pilot is composing an outgoing one, the incoming message is given instant priority on the display. However, the portion of the outgoing message already composed is stored and can automatically be subsequently recalled to the display.

Army Field Code

Discom employs the Army Field Data binary code, normally used for teletype, in accordance with Defense Department policy of standardizing on this code wherever possible.

Eight bits are used for each alpha-numeric character. Six of these identify the particular character, the seventh bit can be used for control function in teletype operation, and the eighth bit is a parity check.

For Discom, bits are transmitted by means of frequency shift keying (FSK), as in teletype operation. Tones of 1.90 kc. and 2.75 kc. are employed to indicate "ones" and "zeros," respectively.

Discom will operate at a data rate of 50 bits per second, and will operate in synchronous manner rather than start-stop as with teletype. Timing is controlled by a crystal oscillator.

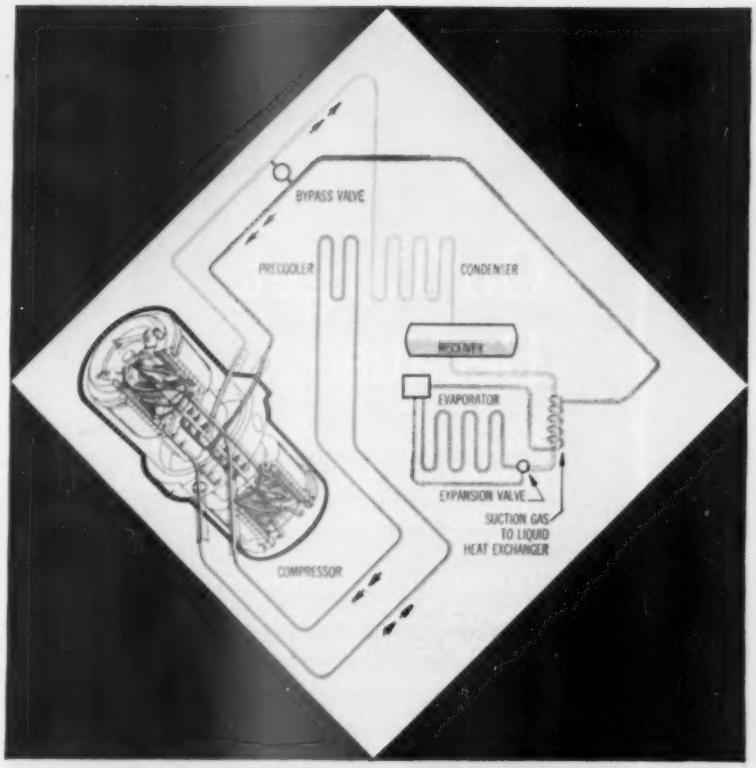
In addition to the parity check inherent in the Army code, Discom employs considerable redundancy to assure accuracy and reliability under adverse propagation conditions. For example, in the selective calling portion of the message, the four-letter call code of the addressee is repeated for a total of three times and the identification of the calling station is given twice.

The two-letter switching or discrete code is transmitted twice during a message and both must be received to cause the system to initiate the desired control or display action.

Discom Operation

Operation of the Discom system in the receiving mode, described by GE's Kious at the recent National Communications Symposium in Utica, N. Y., is as follows: Audio tones (FSK) representing the incoming message are first converted into digital form by the modulation adapter. The message is then routed to appropriate control circuits.

First of these circuits is signal recognition, which identifies pulses as being a



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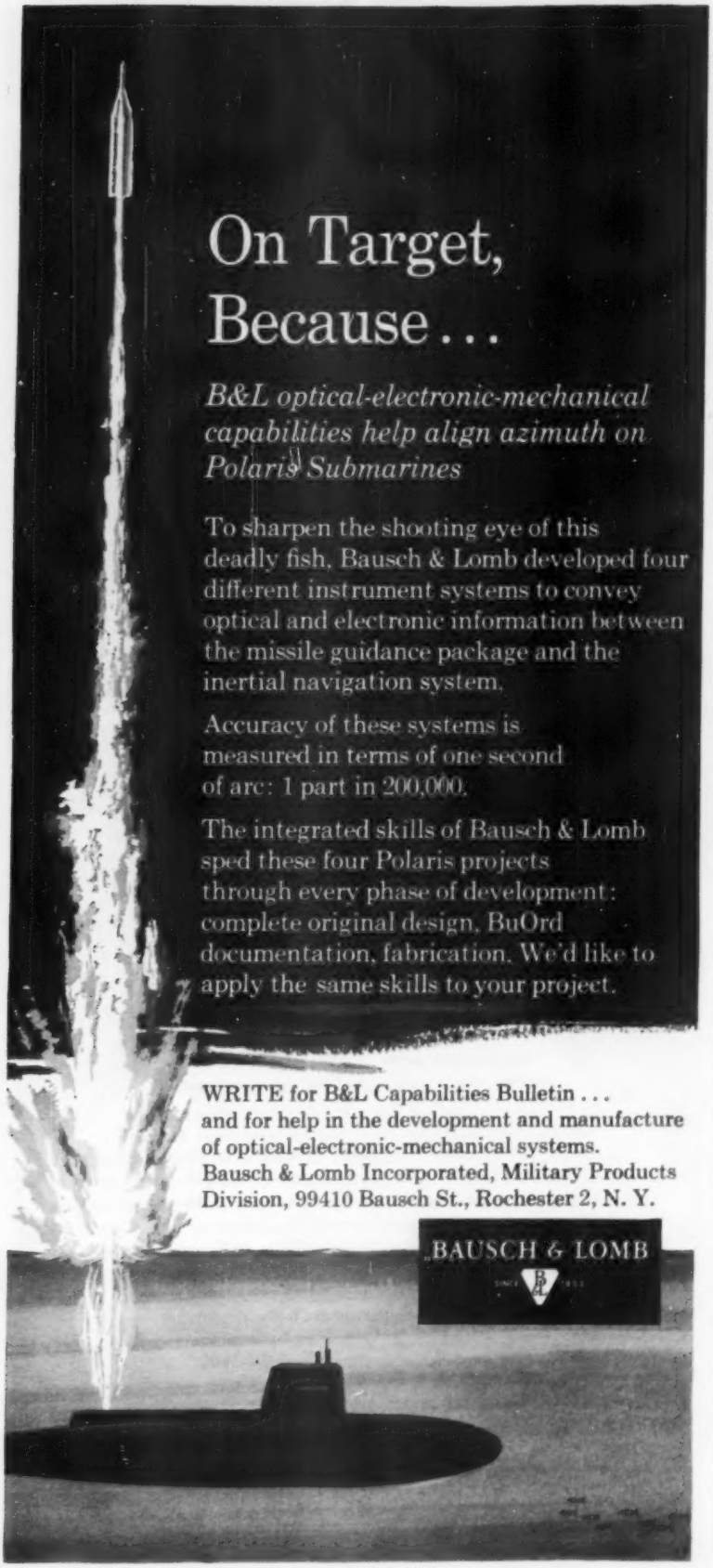
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Discom message and synchronizes the timing circuits. Signal is then routed to the address recognition circuitry where comparisons are made with each of the three calls which individual aircraft's equipment is set to recognize, i.e., individual, group or general.

If the message address is one of these three, it causes the appropriate light to start flashing on the cockpit console and signal is then routed to first mode and then to signature storage. Both the mode control and calling station code letters are then displayed on the console. If the two-letter mode control code indicates that a digital message is to follow, the signal is routed to the proper circuits in the associated digital data group for display on the cockpit console.

Initial tests to be conducted here starting this month will be ground-based evaluations of the selective calling subsystem, to be followed early next year by tests on the digital data subsystem.

By mid-1961, Air Force hopes to begin airborne flight tests using selective calling units installed in about 30 SAC aircraft, nine of which will also be equipped with digital data subsystems. Present plans are to install ground-based Discom equipment at five SAC stations.

The Digital Selective Communication system was developed under Wright Air Development Division sponsorship.

U. S. Plans Tracking Station in S. Africa

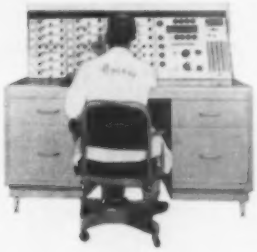
Johannesburg—United States and Union of South Africa have signed a bilateral agreement for location of a deep space tracking station scheduled for operation early next year, in Western Transvaal.

The U. S. will pay the South African government $2.8 million for a 1,250 acre site, located 24 mi. north of Krugersdorp. Station initially will be operated by U. S. personnel, who gradually are to be replaced by South Africans employed by the state-sponsored Council for Scientific and Industrial Research.

National Aeronautics and Space Administration will act as program manager for instrumenting the site, which will contain an 85-ft. tracking dish mounted on a 100-ft. pedestal. Unit will have an initial range of 4 million mi.

Under terms of the agreement, U. S. firms will build instrumentation, and South African contractors will construct facilities.

The deep space network also will include a station in Australia and a station at Goldstone, Calif. The three facilities are about equidistant around the earth to provide complete 24-hr. tracking of space probes.



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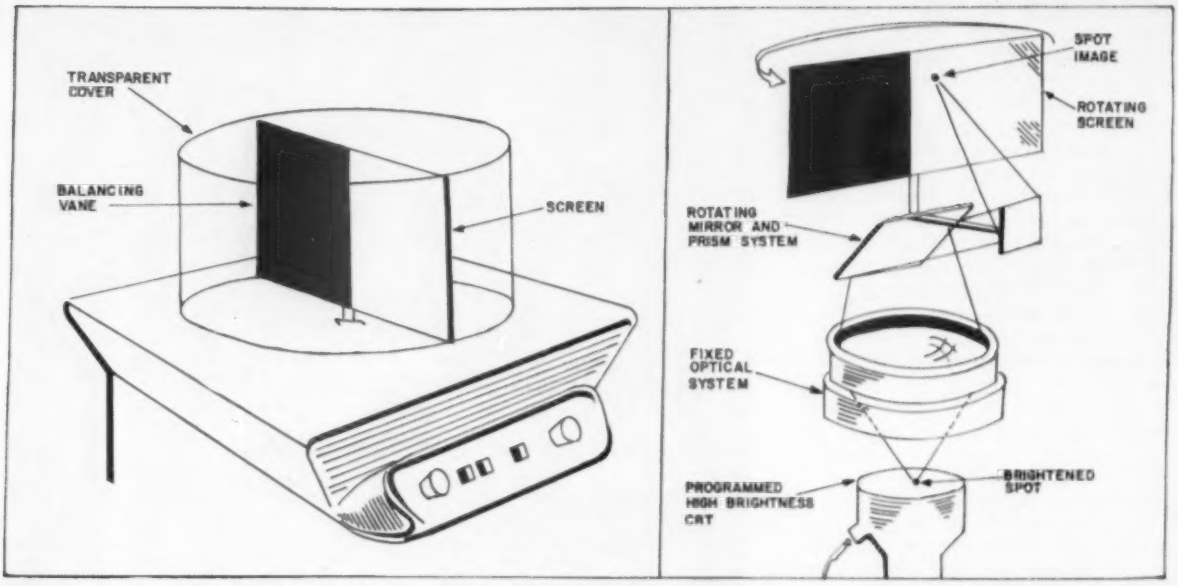


NEW three-dimensional display for air traffic control or air defense, developed by ITT Laboratories, gives 3-D effect from any viewing angle without need for stereoscopic illusion. Display consists of especially programed cathode ray tube whose blips are optically transferred to translucent screen that rotates 1,200 rpm. Persistence of human vision causes spot projected onto screen to appear to hang suspended in space. ITT says new display should be moderate in cost, reliable.

New Display Gives Realistic 3-D Effect

Washington—New type of three-dimensional display, suitable for air traffic control, air battle situation or space surveillance, which does not depend upon stereoscopic illusion, has been developed by ITT Laboratories.

Small scale working model of the new 3-D display was demonstrated here recently to representatives of the military services, the Federal Aviation Agency and the National Aeronautics and Space Administration.

Novel feature of the 3-D display, which is contained in a glass-enclosed cylinder, is that it can be viewed from any angle around its periphery and from any vertical angle. It is almost as if the air traffic or battle were taking place in miniature within the glass enclosed cylinder. The display needs to be viewed in subdued light to be most effective.

Display can be produced in a range of sizes, with cylinder diameters of up to several feet, perhaps larger, according to Anthony Casabona, director of ITT Laboratories' Avionics Laboratory.

How it Operates

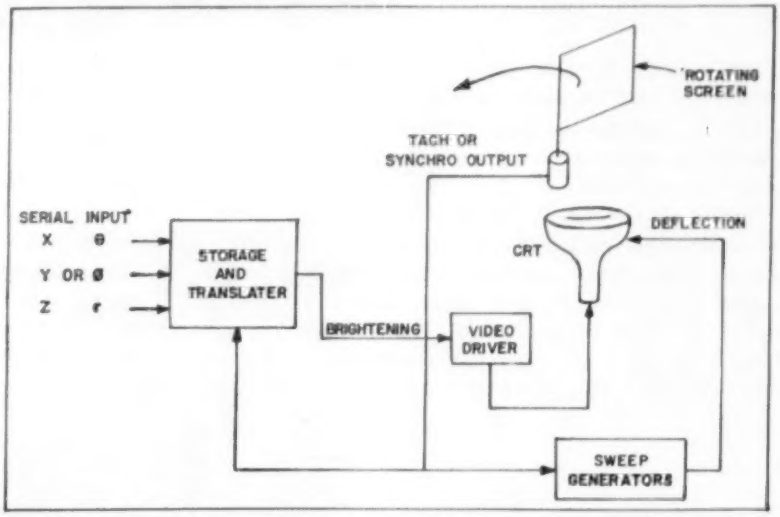
The ITT Laboratories device utilizes a high intensity cathode ray tube, an optical projection system, and a rotating translucent screen within the glass cylinder, in combination with the persistence of vision of the human eye to create a three-dimensional display.

The motor-driven screen turns at approximately 20 revolutions per second.

Any blip, alpha-numeric character or other configuration appearing on the cathode ray tube (CRT) face is optically projected onto the rotating screen.

If the blip represents the position of an aircraft, for example, and the airplane's azimuth position is 90 deg., control circuits cause it to flash on the CRT face and rotating screen at the precise instant when the screen is at a 90-deg., azimuth position, disappearing from the CRT and the screen immediately thereafter.

If the CRT employs an E-scope display, in which target range is displayed along the horizontal axis and its altitude along the vertical axis of the CRT, then the blip projected onto the rotating screen will appear at a corresponding distance from the center of



SPECIAL synchronizing controls are required for cathode ray tube used with 3-D display. Target range and altitude coordinates are displayed on tube face, with instant of display corresponding to target's azimuth position, as shown above.

the glass cylinder and height above its base.

Because of the persistence of vision, the blip appears to be suspended in darkened space within the glass cylinder at an azimuth, altitude and range corresponding to the airplane's actual coordinates relative to sensing radar.

There is no reasonable limit to the number of targets which can be displayed within the glass cylinder. As the rotating screen reaches the azimuth position corresponding to another target, its range and altitude are briefly displayed on the cathode ray tube and optically flashed on the screen.

The model displayed here, using a cylinder measuring approximately 12 in. in diameter and six inches high, employed small lamps instead of a CRT for producing target blips. The blips were broader and not as bright as those which should be realizable with a high brightness projection type CRT, according to Raymond Bassett of ITT Laboratories.

Despite these limitations, the three-dimensional effect was pronounced and instantaneous, requiring no special focusing of the eyes or concentration. In the demonstration model, all of the targets were fixed except one which appeared to flit through the glass cylinder like a butterfly. Because the screen is translucent, the display can be viewed from any azimuth position.

To balance centrifugal forces on the screen, a black vane of equal size is attached on the opposite side of its motor drive shaft. By placing white grid markings on this black vane, and using a stroboscope, it is possible to in effect position the grid alongside any target and determine its three coordinates.

Any alpha-numeric character or configuration that can be produced on a cathode ray tube can be displayed on the rotating screen by means of the optics. (See sketch.) Resolution is limited only by CRT spot size and deflection, and the quality of the optics used, Bassett says. Target blips can be erased as quickly as on a conventional CRT.

If a colored display is desired, a high-speed color wheel (similar to that used in early color television) can be inserted between the CRT and optics, suitably synchronized, to produce any target (s) in any color, Casabona says.

The 3-D display was developed with ITT funds. Company now is anxious to find an interested customer in order to build a fully operable model. This would include the use of a CRT and design of control circuits needed to synchronize CRT display with the rotating screen. Casabona estimates that such a model could be built for approximately $100,000 in less than 12 months.

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▶**New Elint Technique**—Countermeasures technique capable of determining unknown radar's technique within 1% and direction—both azimuth and elevation—to within ½ deg. has been developed by Electronic Specialty Co., Glendale, Calif. Necessary data can be obtained from a single radar pulse, company says. Equipment employing the technique would weigh 30 lb., occupy about 1 cu. ft., according to the company.

▶**Dual-Purpose Satellites**—Earth satellite system which could provide both countermeasures data and emergency communications with airborne bombers will be proposed soon to a number of military agencies by Electronic Specialty Co.

▶**Oscillistor Studies Pushed**—The oscillistor—a contraction of semiconductor oscillator—is being investigated by RCA Laboratories as a possible solid-state frequency selective amplifier. First outlined at the Solid-State Device Research Conference by R. D. Larrabee of RCA, the oscillistor consists of a semiconductor specimen subjected to a magnetic field and connected through a d.c. power supply to a load. Frequency of oscillating voltages at the load are determined by magnitude and orientation of the magnetic and electric fields and the surface condition of the semiconductor. Work is now sponsored by a six-month Wright Air Development Division study contract entitled Molecular Tunable Amplifiers and Band Pass Amplifiers.

▶**West Coast Solid-State Research Conferences Begin**—Series of West Coast solid-state devices research conferences got under way on Oct. 20 and 21 at Stanford Research Institute. Sponsored by the West Coast Subcommittee on Solid State Devices of the American Institute of Electrical Engineers and the Institute of Radio Engineers Professional Group on Electronic Devices, the series will explore many facets of research in semiconductor, magnetic, and electro optical devices. Meetings are open to scientists and engineers who agree not to photograph slides or take notes so as to abet frank exchange of early or tentative research results.

▶**Micromodular Components Division** has been formed by Ling-Temco Electronics, Inc., Dallas, to design, produce and market logic circuitry modules for transistorized computers, custom semiconductor assemblies and high and low voltage rectifiers. Division will be

housed in space leased at 1859 So. Manchester Ave., Anaheim, Calif.

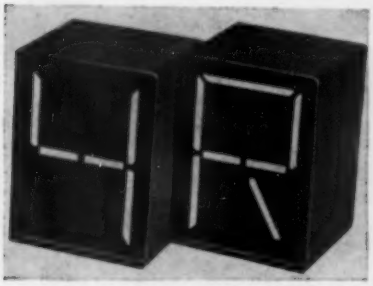
► **Air Force declared** the first Ballistic Missile Early Warning System station at Thule, Greenland, operational Oct. 1. Second BMEWS station at Clear, Alaska, is scheduled to become operational next summer.

► **General Electric** Missile and Space Vehicle Department will build a solar test facility near Phoenix, Ariz., which will permit testing of the largest solar-powered static generating systems now being built for space applications. Facility is to be ready by February.

► **Hamilton Standard Division** of United Aircraft will produce a dead reckoning navigation system for the anti-submarine hydrofoil ship being developed for the Navy by Boeing Airplane Co. (AW Sept. 19, p. 171). System would include a navigation plotter; navigation analog computer; ship's course indicator; ship's speed and distance indicator; and three control units, including range and bearing transmitters.

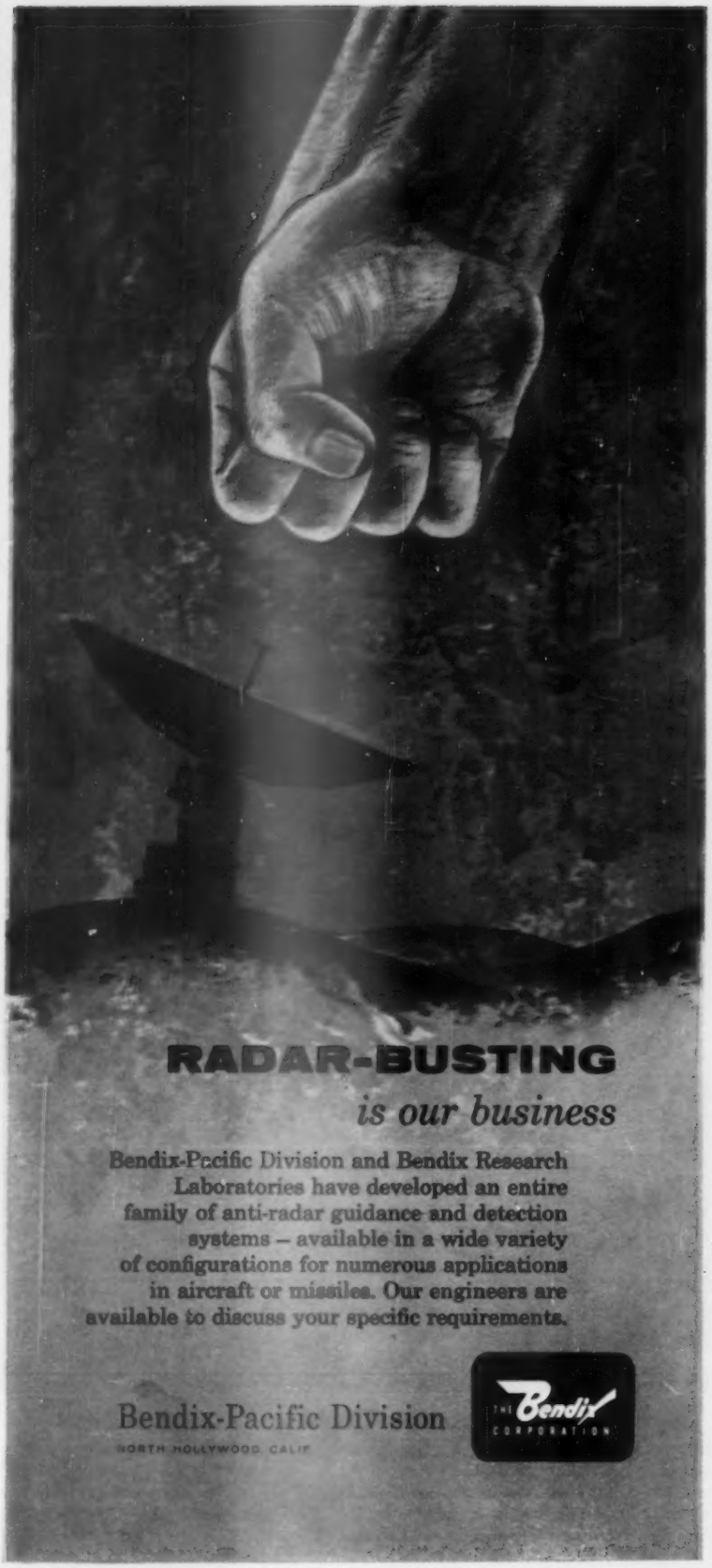
NEW AVIONIC PRODUCTS

• **Alpha-Numeric readout modules,** visible to 70 ft., display any English-alphabet letter and any numeral from 0 through 9 in characters 3 in. high, 2 in. wide. Indicating segments are white against black background. Operates on low power d.c. signal, from 1 to 30 v., with response time of less



than 0.1 sec. Two basic types: 203 (momentary) and 204 (momentary or pulse-controlled latching). Modules, which can be fitted together or panel mounted, measure 3⅞ in. high, 2⅛ in. deep, 2¼ in wide. Manufacturer: Allard Instrument Corp., 146 E. 2nd St., Mineola, Long Island, N. Y.

• **Voltage-to-frequency converter,** called Magaverter, produces output square wave whose frequency is directly proportional to applied (input) voltage. Input-output linearity is within ¼% in standard configuration, while "Red Line Magaverter" has linearity of 0.1%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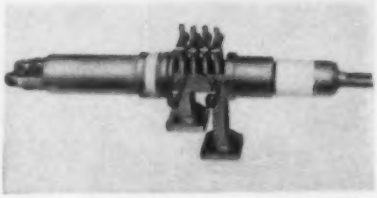
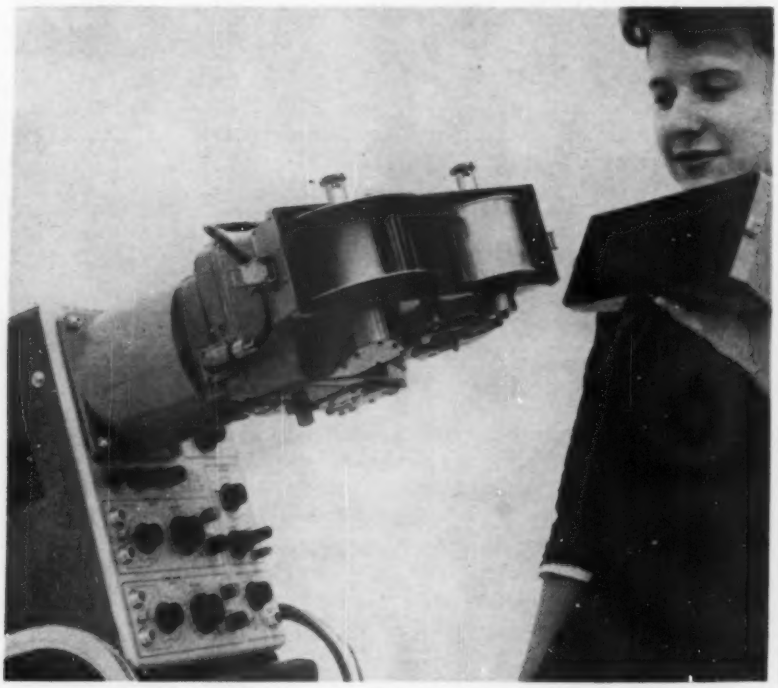
with temperature stability better than 50 ppm/deg. C., according to manufacturer. Eight standard models provide full range of output frequencies, from 30 cps. to 25,000 cps. Maximum full scale frequency is adjustable over a 4:1 range with built-in attenuator. Standard units have input voltage ranges of 0-1, 0-10 and 0-100 v. The static, solid-state device measures approximately 4¼ x 3¾ x 5½ in. Manufacturer: Pioneer Magnetics, Inc., 850 Pico Blvd., Santa Monica, Calif.

• **Militarized tape perforator,** strengthened for use in ground support equipment, operates at speeds from 0-30 columns per second on standard code channels 5, 6, 7 or 8. Perforator is available with punches for metalized mylar tape. Manufacturer: Telecomputing Corp., Data Instruments Div., 12838 Saticoy St., North Hollywood, Calif.



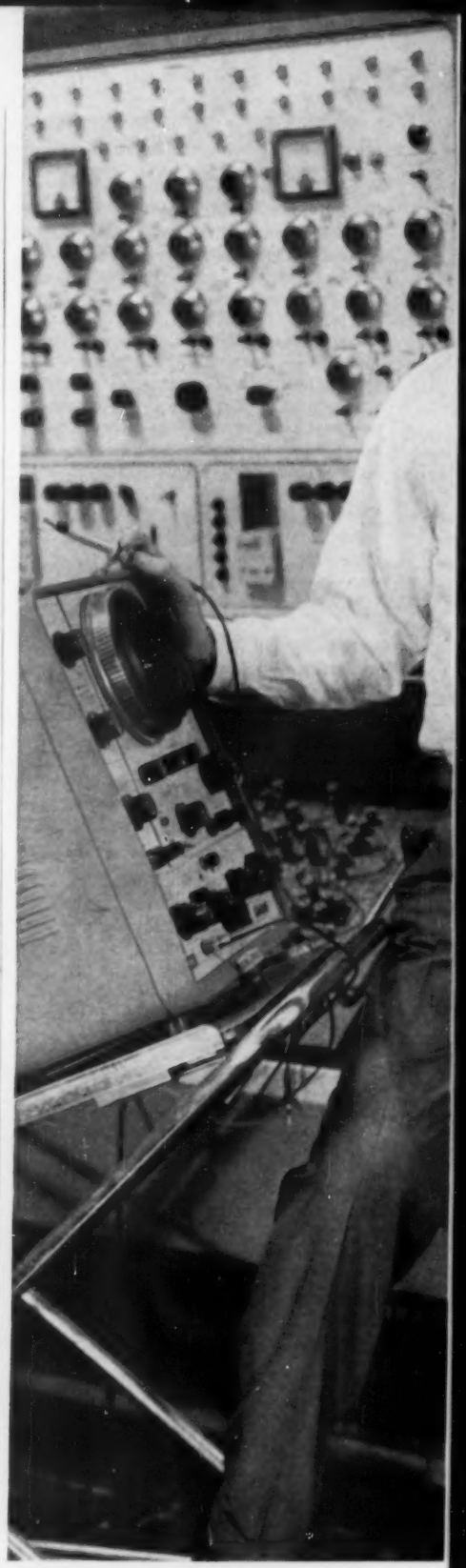
• **High-power X-band klystron,** Series VA-849, rated at 20 kw. continuous-wave (CW), for applications requiring very low AM and FM residual noise, is called highest CW power klystron ever offered for X-band, by manufacturer. Klystrons cover frequency range of 7,125 to 8,500 mc., are tunable over a 60 mc. band, provide power gain of 37 db. and minimum bandwidth of 30 mc. The synchronously tuned power gain and bandwidths are 53 db. and 15 mc., respectively. Tubes are focused electromagnetically. Manufacturer: Varian Associates, 611 Hansen Way, Palo Alto, Calif.

• **Miniature telemetry power amplifier,** Type 1114A/1114B, with 15 watts output, weighs only 14 oz. Amplifier operates over entire 215 to 260 mc. telemetry band, at altitudes up to 100,000 ft. Manufacturer: Tele-Dynamics Div., American Bosch Arma Corp., 5000 Parkside Ave., Philadelphia, Pa.



Radar-Oscilloscope Camera Processes Film

Radar-oscilloscope strip-film camera processes film within the camera in one minute without tanks of processing solution. The variable speed camera, with transport speed range of 0.25 to 12.5 in./sec. uses 70-mm. film in lengths up to 100 ft. Camera and processing unit weigh 15 lb. Device will be available in January. Manufacturer: Chicago Aerial Industries, 550 West Northwest Highway, Barrington, Ill.



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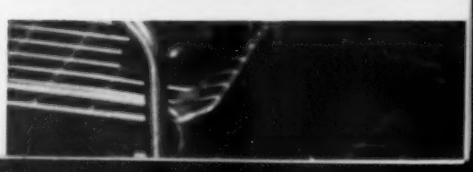

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Oscillating-Electron Ion Engine Tested

By Michael Yaffee

E. Hartford, Conn.—United Aircraft Corp. has entered the fast-growing electrical rocket propulsion field with an unusual oscillating-electron bombardment ion source that produces a high-velocity, electrically neutral plasma beam.

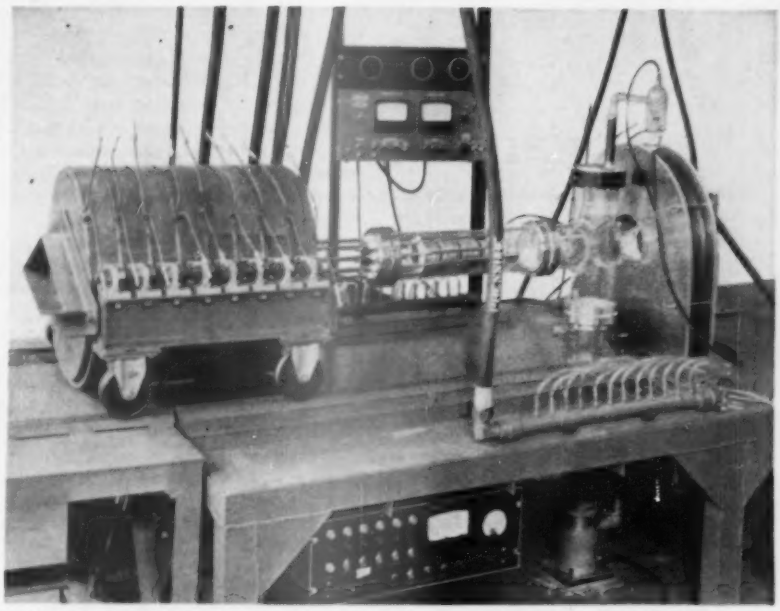
United's Research Laboratories, which developed the ion drive with company funds, now has a research and development contract from the Air Force Research Division of the Air Research and Development Command to investigate the operating mechanisms of the device. The contract is to run for 13 months and, it is hoped, will lead to a development contract.

Principal attraction of UAC's ion drive is its reported ability to produce an electrically neutral beam. This alleviates the space-charge effect—the buildup of an electrical charge on the vehicle which would draw the oppositely charged particles back onto the vehicle instead of permitting free exit into space—which limits the beam current or power of many of the other proposed ion rocket engines. This means that theoretically there is no limit to the thrust capability of the UAC device and that depending upon the availability of a suitable nuclear reactor or other power supply it could produce over 1,000 lb. of thrust if desired, according to UAC scientists.

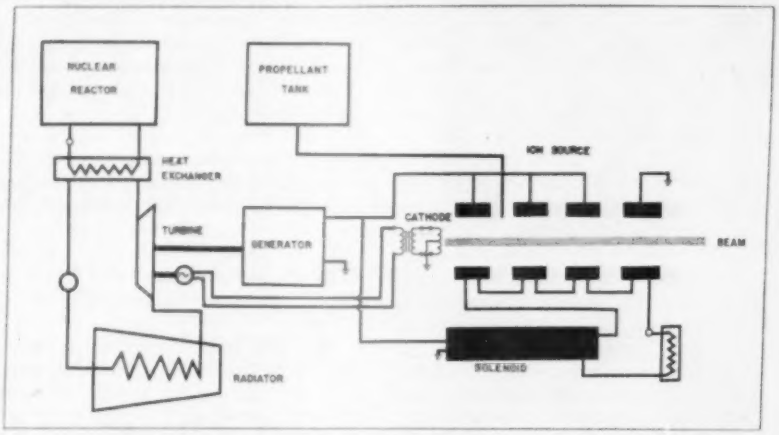
Strong Competitive Factor

Moreover, they feel that this particular ion drive gives UAC a strong competitive position with other companies whose ion engines still require development of means to successfully inject neutralizing electrons downstream. Demonstration model of the UAC ion engine could be flown in a satellite within two years using a battery power source, says the company. First actual application of an ion engine is expected to be in the proposed 24-hr. communications satellite, wherein an ion engine, probably powered by the North American Aviation SNAP-8 nuclear reactor, will be used to boost the satellite from a near-earth orbit to a "stationary" 22,500-mi. orbit.

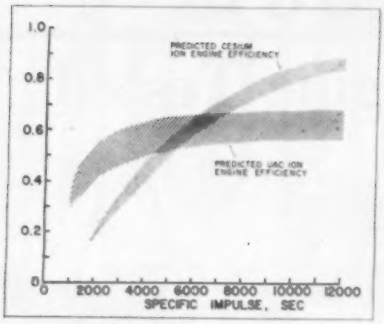
At the present time, there are four oscillating-electron ion sources in operation at United Aircraft Corp. Research Laboratories here, each capable of producing up to .01-lb. thrust according to company scientists. The first unit, which was built originally for in-



WITH SOLENOID CART rolled back, United Aircraft Corp.'s oscillating-electron ion engine can be seen above inside glass vacuum system used to simulate space environment.



COMPLETE electrical propulsion system based on UAC ion engine is diagrammed above. Scientists in UAC Research Laboratories electrical propulsion facility (below) check three of the group's four ion engine test stands.



PREDICTED optimum operating efficiencies of cesium ion drive and United Aircraft ion engine are plotted (on vertical scale) against specific impulse. Chart shows UAC device reaches its best efficiency (50-60%) at lower specific impulse than cesium engine.

vestigation into the physics of very high temperature plasmas, is still being used primarily for the non-propulsive plasma research.

The other three units were designed and are being utilized solely for space propulsion research. Among other things, UAC scientists are investigating different propellant feed systems. One device, for example, is being used for a study of condensable propellants such as mercury which may prove amenable to pumping simply by condensing the expellant on a cold surface instead of requiring the large vacuum pumps now being used in test-stand work. In another unit, UAC scientists are investigating the use of carbon dioxide as a propellant and, later, will probably explore the propellant potential of other human waste byproducts.

UAC scientists readily point out that their ion drive has another important advantage in that it can use any material as a propellant that can be vaporized at a temperature below that of the container material melting point which, in the case of tungsten tankage, would be approximately 6,200F. The UAC ion drive, says group supervisor Dr. Russell Meyerand, Jr., is not limited as many other ion rockets are to the high cost, low ionization potential, alkali metals such as cesium. To date, UAC researchers have used carbon dioxide, helium, neon, argon, hydrogen, nitrogen, mercury, krypton and even hot breath (contained in a blown-up balloon) as working fluids.

Ion Source

Basically, the UAC oscillating-electron ion source consists of a cathode, five anode rings and a ground ring joined to form a tube, a series of pancake solenoids which slip over the tube, and a backplate at one end of the tube through which the cathode and propellant feed line project.

The other components that would go to make up a complete propulsion system—nuclear reactor or other power source, heat exchanger, turbine, generator and radiator—are not part of the present UAC Research Laboratories project which is concerned only with ion drive itself. For the most part, these other components will be common to all electrical propulsion systems and are generally being investigated independently. North American Aviation, for example, is building the SNAP 8 reactor, Aerojet-General is developing the power conversion equipment for the reactor, and Pratt & Whitney and other groups are doing research on space radiators.

Development of each of these components or subsystems entails its own special problems. In the case of the radiator, for example, walls and tubing will have to be made strong enough to protect against meteoroid penetration and this could add significantly to the weight problem. It is conceivable, says one NASA scientist, that in an electrical propulsion system using a 100-megawatt reactor and with a 20-megawatt ion drive, radiator weight might run anywhere from 42,000 lb. to more than 1 million lb.

How it Works

Briefly, this is how UAC's oscillating-electron bombardment ion drive works. Alternating current is fed to the cathode which is a nickel screen covered with lanthium hexaboride. The electrons emitted from the cathode and attracted by the five positively-charged anode rings travel down to the open end of the tube. Here, the electrons come under the influence of the grounded ring which forms the last segment of the tube and is at the same potential as the cathode. Thus, instead of escaping out the end of the tube, the electrons are repelled back toward the cathode. Trapped in effect in this potential "well," the electrons oscillate axially in the tube.

Although some of the electrons travel radially to the walls of the tube where they are lost to the anodes, most of them are constrained by the solenoid's magnetic field and oscillate along the longitudinal axis of the tube. Current through the solenoid coil surrounding the tube creates a strong magnetic field in the tube whose lines of force run parallel to the tube axis. The charged electrons and ions are tied to these lines of force and move in helical paths along them.

The electrically neutral working fluid is introduced into the tube or duct at pressures of 10^{-3} to 10^{-4} mm. of mercury. (In the laboratory, the ion drive is enclosed in a glass vacuum system which, of course, would be unnecessary in the natural vacuum of space.) Bombarded by the oscillating electrons, the neutral propellant molecules lose an

General Electric contributes

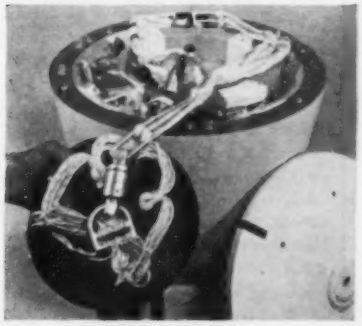
How NERV Space

NASA's Nuclear Emulsion Recovery Vehicle, developed by General Electric Missile and Space Vehicle Department, is highest space probe ever to be recovered.

Another major step in space exploration was achieved September 19 when NASA's first NERV—Nuclear Emulsion Recovery Vehicle—was successfully recovered after a 1200 nautical mile-high flight into the Van Allen space radiation

to another space FIRST . . .

FOR NASA's Goddard Space Flight Center, MSVD built this Nuclear Emulsion Recovery Vehicle. Here a scientist examines the payload which extends during flight to record a visual profile of ionization particles in the Van Allen radiation belts. Below, NERV's recovery package is shown.



Returns Highest Radiation Measurements

belts. NERV brought back detailed measurements of the belts' radiation intensity.

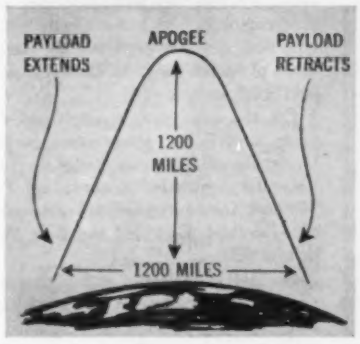
Carrying a nuclear emulsion payload deep into space, NERV "photographed" tracks of the belts' charged particles in ranges from 5 Mev upward. Precise measurements of this radiation must be obtained before optimum shielding can be designed for manned space vehicles.

Recovery of the vehicle after flight—rather than relying only on telemetered information — permits scientists to analyze the nuclear emulsion directly. Thus they acquire a clearer picture of the composition of the belt, the intensity of the charged particles, their velocities, distribution and direction of movement.

General Electric's Missile and Space Vehicle Department designed and built the Nuclear Emulsion Recovery Vehicles for the National Aeronautics and Space Administration's Goddard Space Flight Center.

NERV is readily adaptable to many research missions . . . where exposure of the payload to the space environment and recovery after flight is desired.

To learn more about NERV and other MSVD programs leading toward man's entry into space, write to Section 160, General Electric Missile and Space Vehicle Department, Philadelphia 1, Penna. 160-82



MISSION PROFILE is illustrated above. After burnout of the rocket's four stages, a linear actuator extends the emulsion package. Payload is exposed through its apogee of approximately 1200 nautical miles and until the vehicle is within approximately 250 nautical miles of the earth upon return.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A DEPARTMENT OF THE DEFENSE ELECTRONICS DIVISION

Electrical Rockets

Current interest in electrical propulsion systems is due perhaps more than anything else to the development of the new, high-thrust chemical boosters with large payload capabilities.

Low-thrust electrical rocket propulsion systems are most effective and practical in space where they can produce almost unlimited jet velocities with an extremely small consumption of fuel. Too, in space, where the effect of gravity is negligible, the large mass of the electrical propulsion system—the ion drive along with the power supply, turbine, generator and propellant system—is no longer the problem it is on earth or in the atmosphere.

Basically, electrical propulsion systems can be divided into three groups: the electrostatic rocket in which the working fluid (the positively-charged ions and negatively-charged electrons) is accelerated by voltage alone to the desired ejection velocity; the electromagnetic rocket in which an electrically induced magnetic force is used to accelerate the charged particles; and the electrothermal rocket in which electrical energy is used just to heat a propellant gas which is then expended rearward through a nozzle without the aid of electrical or magnetic fields. The government, through NASA, the military services and contracts with private industry, is currently investigating all three groups.

These three basic types of electrical propulsion are then further divided and classified as follows:

• Electrostatic rocket: most electrical propulsion work today is concentrated in this category. Aerojet-General, Convair, Curtiss-Wright, Electro-Optical, General Electric, Goodrich-High Voltage, Hughes, Martin, Rocketdyne, Thompson Ramo Wooldridge, and United Aircraft are believed to be among the industry firms presently carrying out research and development in this area.

A. Ion rocket engines.

1. Surface contact engines, probably the most popular today, in which ions are formed when materials with low ionization potentials such as cesium and rubidium come into contact with the heated surfaces of metals such as tungsten and platinum which have high work functions.

2. Bombardment engines in which ions are formed by electron impact on neutral propellant material. Examples of this group are the duo-plasmatron and the oscillating electron drives.

B. Colloid rocket engines. Here, charged particles (colloids or even ionized dust) much larger and heavier than ions (but still generally less than one micron in diameter) are accelerated electrostatically.

• Electromagnetic rocket: At the present time, there are roughly three basically different types of plasma or magnetohydrodynamic (MHD) rocket engines. In all of them, the plasma is produced either by arc discharge or induction heating and then accelerated electromagnetically.

A. Traveling wave accelerator. Plasma produced by induction heating is caught between traveling magnetic waves and accelerated through a tube.

B. Plasma gun. Plasma is accelerated by current flowing within the plasma interacting with an externally produced magnetic field except in the case of the pinch type engine in which the magnetic field is internally generated. Besides the pinch type device, the engines in this category include the magnetohydrodynamic shock tube, plasmoid guns, MHD rotor accelerator, Kolbe tube, and transient magnetic field accelerator.

For the most part, research and development on electromagnetic propulsion is being carried out in government and university laboratories such as those of University of California Radiation Laboratory at Livermore, Los Alamos Scientific Laboratory, Stevens Institute of Technology and Temple University and the National Aeronautics and Space Administration. In industry, Republic, General Electric, Fairchild, Lockheed and Borg Warner are among those believed to be working in this field.

C. MHD accelerator and plasma pumps. Plasma produced by external means is pumped and accelerated out a duct by a force created by crossed electrostatic and magnetic fields applied to the plasma.

• Electrothermal rocket: As indicated by the name, this group technically falls between the true electrical rocket and the true thermal rocket. In the arc jet or plasma jet engine, the working fluid or gas is heated by electric arc discharge and expanded supersonically through a rocket nozzle to produce thrust.

Most of the work currently under way on electrothermal propulsion devices stems from the development and use of plasma jets as research tools in re-entry vehicle studies.

Avco, General Electric and Giannini are among the firms reported to be working presently on electrothermal propulsion units.

electron and become positively charged ions.

The secondary electrons, those knocked off the propellant molecules, also become trapped and oscillate.

The electrostatic potential well whose profile has been shaped by the researchers (by altering the voltage on the different electrodes) to trap electrons, acts as a potential "hill" for the ions, accelerating them in a directed beam out of the tube. At the same time, say UAC researchers, it has been found that as a result of the system's high electron mobility, the copious quantities of electrons available in the oscillating electron current and the presence of ion space-charge field, electrons are drawn into the ion beam, creating an electrically neutral plasma exhaust. The velocity of the exhaust beam can be altered to suit a specific mission requirement, they add, by altering the voltages on the electrodes or by using a different molecular weight propellant.

Not only is the exhaust beam neutral in density (that is, the number of negative electrons equals the number of positive ions in a given volume of expellant), it is emphasized, but it is also equal in current (that is, the number of electrons and ions ejected in a given amount of time is the same). To verify this, UAC researchers have transmitted microwave beams through the exhaust. Diffraction of the beam indicates that electrons are definitely present in the exhaust, and measurement of the phase shift of the microwave beam shows an equal density of electrons and ions. UAC researchers have also put a Langmuir probe in the exhaust and independently measured the plasma potential and electron density.

This ability to produce an electrically neutral beam, which is the principal advantage claimed for the UAC device over other ion drives, is most important, says Dr. Meyerand. If the density of electrons and ions in the exhaust were unequal, a space charge would build up in the ion drive. The excess type of charge would slow down similar type charges trying to leave the exhaust duct, therein limiting current and thrust and also, by repelling each other, would spread the exhaust beam apart, creating a loss in horizontal thrust components.

If the currents (number of charged particles exhausted in the same time) are unequal, a charge would build up on the vehicle. This would cause oppositely charged particles in the exhaust to curve back onto the vehicle and after perhaps only a microsecond, the engine would stop.

In other types of ion engines, an electron emitter is located downstream to reinject electrons into the ion beam, generally right after the beam leaves the accelerator section. However, beam

neutralization is proving a big problem; and, says Dr. Meyerand, there is still some doubt that electrons can be successfully injected into ion beams.

As far as the performance of the UAC Research Laboratories' oscillating-electron ion drive goes, Dr. Meyerand and his group have computed a number of design parameters.

Among the more significant of these are the following:

• **Specific impulse.** The UAC ion rocket will operate at specific impulses ranging from 2,000 to 10,000 sec.

• **Thrust.** To date, the device has produced thrusts estimated at .01 lb. In the future, thrust theoretically will be limited only by the available power supply.

• **Efficiency.** Present engines are running at 10-25% efficiencies; later units should achieve efficiencies as high as 50-60%.

• **Thrust-to-weight ratio.** This ratio should maintain itself at 10^{-4}.

• **Beam current and power.** UAC scientists so far have obtained beam currents of 5 amp. and beam powers of 400 watts and eventually expect to obtain currents of 20 amp. and powers up to 10 kw.

• **Voltage.** Present and anticipated operating voltages range from 200 to 1,000 volts.

• **Mass.** Ion drive itself will weigh 200 lb., while the power supply and other propulsion components will weigh approximately the same as for other electrical propulsion systems.

• **Power consumption.** Present consumption is 1 kw. and will go to 300 kw. in later units.

• **Propellant consumption.** Operating at a specific impulse of 4,000 sec. and at a power input of 16.3 kw., a UAC ion rocket will use .08 lb. of argon per hour to produce a thrust of 0.1 lb.

• **Design lifetime.** UAC researchers estimate 10,000 hr. or more.

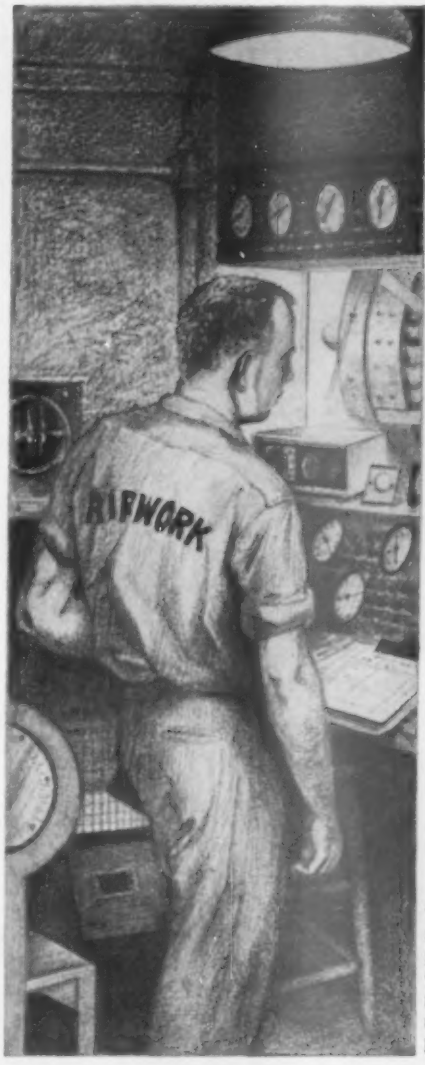
Most ion propulsion systems designed so far have specific impulses between 5,000 and 25,000 sec.; and, according to the Martin Co.'s William R. Corliss, by 1965, the cesium surface contact ion rocket is expected to achieve an efficiency of 73%. For certain missions, however, particularly those of more immediate interest such as raising an earth satellite to a 24-hr. orbit, says Dr. Meyerand, specific impulses in the 2,000-5,000 sec. range appear more attractive.

It is in this range, he adds, the oscillating-electron ion drive outshines other electrical rockets such as the cesium ion drive. For example, he says, in raising a satellite from a 300-mi. orbit to a 22,500-mi. orbit, the cesium rocket would take 30 days and would have a payload-to-gross weight ratio of only 40% while the oscillating-electron engine could do the job in 15 days with a payload-to-gross weight ratio of 50%.

The reason for this, he says, is that the oscillating-electron ion engine achieves its best predicted efficiency (50-60%) at a specific impulse of approximately 2,500 sec. The cesium ion rocket doesn't match this efficiency until reaching specific impulses of 5,000 to 6,000 sec., and doesn't achieve its best predicted efficiency (75-85%) until operating at specific impulses above 11,000 sec.

It is in the specific impulse range of 2,000-5,000 sec., Dr. Meyerand says, that the problem of space charge current limitation becomes most severe for the surface contact ion type of engines. For a cesium ion drive to overcome the space charge limitation and produce more current (ions/sec.) or thrust, the voltage applied to the anodes can be increased, but this means a much larger and heavier power supply will be needed. While thrust goes up linearly with the exhaust velocity or specific impulse, Dr. Meyerand points out the electrical energy required to accelerate the charged particles to a given exhaust velocity goes up with the square of the velocity.

It is unlikely that UAC's oscillating-electron ion engine will ever require more than 1,000 volts, he says, while



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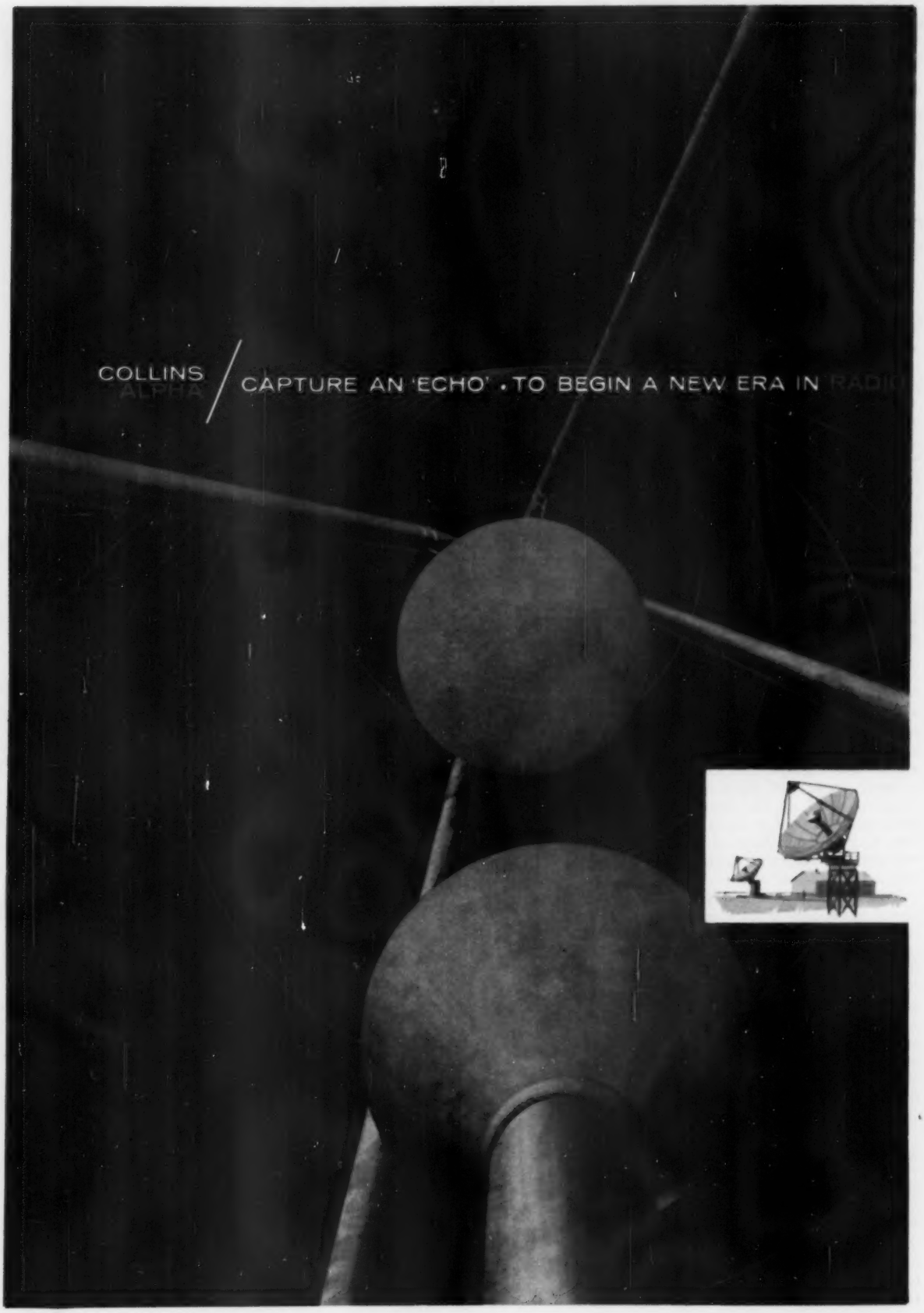
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The first two-way voice communication using the Echo I satellite was made by Collins Radio Company in Iowa and its systems subsidiary, Alpha Corporation of Texas. Collins also conducted signal measurements, relayed teletype messages and even a news photo. Participation in NASA's Echo project is representative of Collins' space research. Other studies involve upper atmosphere radiation, and systems evaluation associated with space vehicle programs, including a lunar "soft" landing. Collins also designed the first radio sextant and provided communication systems for Project Mercury and the X-15 rocket ship.

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it is conceivable that other electrical drives such as the cesium rocket will require potentials as high as 50,000 volts. Among other things, it is claimed, this will make the oscillating-electron device more compatible with low voltage thermionic and thermoelectric units and could result in considerable savings in weight.

There is, of course, still a great deal of work to be done before the oscillating-electron ion drive becomes a flyable reality. Among the problem areas and little understood phenomena currently under study or marked for future investigation here at United Aircraft Corp. Research Laboratories are the following:

• **Design of the potential** "well" and "hill." In an effort to obtain greater thrust, UAC scientists are experimenting with different electric field shapes, seeking ways to increase ion current while maintaining a relatively constant ion energy distribution.

• **Thrust loss.** Related efforts are under way to understand and reduce the phenomena of thrust loss caused by ions going to the cathode instead of out the other end. By altering the shape of the electrical field, among other things, UAC researchers hope to reduce ion loss to the cathode at least to 10%.

• **Sputtering.** A problem common to most electrical propulsion systems, sputtering is caused by the highly accelerated maverick ions that hit the cathode and knock off chunks of material. UAC researchers hope to minimize this problem again through better electrical field design and through use of stronger cathode materials, different cathode designs and different propellant injection points.

• **Electron loss.** Some oscillating electrons are lost quickly to the anodes, creating heat and having done little useful work. This also means that more current has to be supplied to the cathode so that new electrons can be drawn off to replace those that are lost. Again through improved "well" design and solenoid optimization, researchers hope to trap electrons more effectively.

• **Efficiency.** UAC scientists are working on ways to improve the over-all efficiency of their ion drive. This overall figure is actually derived from two components, working fluid utilization efficiency and power conversion efficiency (beam power/input power).

To improve propellant utilization efficiency (that is, minimize the amount of working fluid that passes out of the device before it is ionized) and power conversion efficiency, experimenters among other things are varying the shape of the potential "well," strength of the magnetic field, gas pressures, gas feed points, cathode and anode design, and voltage levels.

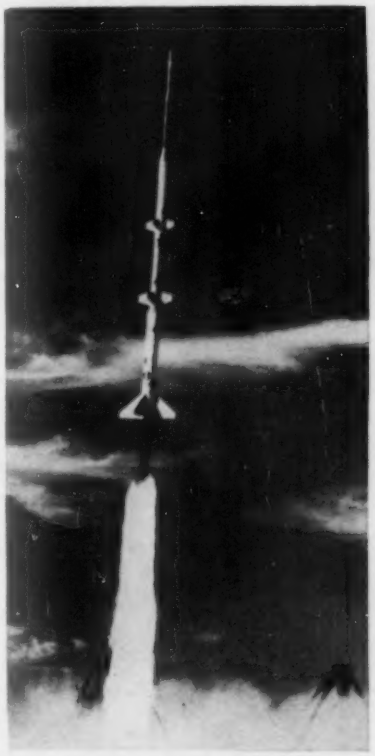
Large Solid Booster Study Areas Assigned

Washington—Three companies selected to conduct preliminary design studies on solid propellant boosters weighing 1 million and 7 million lb. have been assigned specific study areas by NASA.

Grand Central Rocket Co. will study and design a million-pound first stage; Thiokol Chemical Co. has been assigned the 7 million lb. first stage, and Aerojet-General will study and design stages for vehicles in both weight classes.

Solid propellant super booster motors theoretically can have thrust levels two to three times the vehicle weight, and the NASA studies are being conducted to determine the ability of solids to compete with chemical engines in Saturn and Nova booster classes.

The three firms will conduct independent six-month studies. They will share approximately $225,000 in the contracts (AW Sept. 19, p. 28).



Argo Flare Carrier

Aerolab Development Co.'s Argo E-5 will be used to carry flash cartridges to 1,000-mi. altitude in mapping experiments to begin in January at Wallops Island, Va. USAF project includes use of widely spaced cameras which will use triangulation method to determine the exact distance between camera sites. Aerolab is contractor for five-stage rockets and payloads.

Dyna-Soar Flight Tests Will Involve Major Geophysical Experiments

By William S. Reed

Los Angeles—Dyna-Soar is expected to serve as a testbed for geophysical experiments during its flight-test program, Capt. F. R. Anderton of USAF Flight Test Center, Edwards AFB, told the Society of Experimental Test Pilots here.

Anderton, an aeronautical research engineer in the Manned Spacecraft Engineering Office of the Flight Test Center, said geophysical experiments have been proposed to determine upper atmosphere density, pressure, temperature and composition as well as meteorite and geomagnetic measurements.

Major objectives of the Dyna-Soar boost-glide vehicle program will be to explore the hypersonic flight regime, investigate maneuvering capabilities, effect a conventional landing through pilot control, and to evaluate man's capability as an integral part of the control system loop.

An example Anderton used to describe the magnitude of the research program is that it will be necessary to design and fabricate special-purpose bolts for Dyna-Soar which can carry loads uniformly yet be resistant to the extreme temperatures encountered during hypersonic flight.

Significant advances have been made in the knowledge of hypersonic flow, but there are many perplexing problems yet unsolved. Mathematical description of hypersonic flow is a difficult problem especially when real gas effects, viscosity and vehicle configuration are considered. Since present theoretical and empirical expressions allow only approximate solutions, it has become necessary to rely upon wind tunnel data for evaluation of hypersonic flow field parameters. An extensive free-flight model and wind-tunnel test program is scheduled for Dyna-Soar which is roughly more than three times more extensive than that expended on the North American X-15. The tests will take place in at least five different wind tunnels so that the limitations of any one tunnel can be eliminated from the data, he said.

Transonic Tests

Transonic tests are of particular interest because of the compromises made in this regime to provide satisfactory aerodynamic characteristics at hypersonic speeds.

The design of a control system for a hypersonic glider is a difficult task because of the wide range of speed and altitude through which the vehicle operates. Lack of aerodynamic damping at high Mach numbers and the problem of low efficiency of aerodynamic control with the vehicle's long period motion at low aerodynamic pressures combine to make vehicle control at high speed and altitude difficult. Anderton pointed out that there are severe cross-coupling effects also attendant with the high angles of attack characteristic of Dyna-Soar. Information from the X-15 flight-test program will be helpful since that aircraft will investigate the region of flow dynamic pressure and will derive information on the operation of reaction control systems.

The flight-test program consists essentially of these three phases:

- **Air launch phase** which will have the Dyna-Soar glider carried aloft under a Boeing B-52. A small rocket engine will enable the Dyna-Soar to reach low supersonic speeds allowing the investigation of low supersonic stability and control characteristics, trim ability and maneuvering capabilities. Data also will be gathered on subsystem operation, vehicle handling qualities, landing characteristics and structural integrity. Inherent in these objectives is the determination of vehicle lift-drag characteristics, stability augmentation system operation, center of pressure shift, and stability and control.
- **Unmanned ground-launch phase** has as its main objectives the functional and structural demonstration of the booster-glider combination and the evaluation of the escape systems. Vibration and noise also will be evaluated at this time. Demonstration of separation characteristics; i.e., separation of the second stage of the booster from the first, and separation of the vehicle from the second stage, also is an important part of the unmanned program. If feasible, the vehicle will be glided after separation from the booster in order to obtain aerodynamic performance and stability and control data.
- **Manned ground-launched program** will consist of a series of flights in which the booster burnout velocity is incrementally increased as the program proceeds. Flights are planned to explore the stability and control and thermodynamic flight parameters in a systematic and progressive manner so that maximum safety and confidence in each flight can be maintained. During the manned program, data such as pressure, temperature, velocity and altitude will be obtained. Determination of man's contribution of discretionary judgment to achieve optimum performance and reliability also will be achieved during flight test as well as an evaluation of the vehicle's subsystems.

Program status of the X-15 rocket research vehicle was reviewed by Maj. R. M. White, USAF, and J. A. Walker, NASA, including their respective altitude and high-speed record flights. White described the sequence of events which occurred on his altitude flight of Aug. 12 as follows:

After launch from the B-52 at 45,000 ft., all eight thrust chambers were lighted while an 8-deg. angle of attack was maintained. With the application

Photo Bounced Off Courier Satellite

This photo of four U. S. Army scientists responsible for Project Courier communications satellite was sent from U. S. Army Signal Corps ground station (AW Oct. 17, p. 71) to the satellite, received and then retransmitted to Ft. Monmouth, N. J. Scientists (seated) are Walter P. Teetsel, left, in charge of ground sites, and Samuel Findler, ground station manager. Standing are Project Manager P. W. Siglin, left, and Director G. F. Senn.

of thrust, the initial altitude loss was arrested at about 39,000 ft. and a climb maintained to 60,000 ft. At this altitude, the aircraft was accelerated to Mach 1.9, after which a 1.5g pullup was initiated and maintained until attaining full back stick at 18.5-deg. angle of attack. Full aft longitudinal control corresponds to 35 deg. of stabilizer deflection and the airplane's pitch angle at this point was 48.5 deg. Engine burnout occurred at 118,000 ft. at an angle of attack of 10 deg.

Following a zero-lift trajectory, maximum altitude was reached. At burnout, 10-deg. rather than zero-deg. angle of attack was maintained. Confidence in the analog simulator work which indicated satisfactory stability at low dynamic pressure was one of the reasons for maintaining the 10-deg. entry angle of attack, rather than going to zero lift over the top. Dynamic pressure over the top was 10.6 psf. at Mach 1.65. The aircraft response was slow but positive. An angle of attack oscillation of ±3 deg. within an 8-sec. period persisted over the top but was hardly noticeable, except for movement of the angle of attack needle. After passing peak altitude, White concentrated on stabilizing for the entry. The aircraft rotated easily to a maximum 2.6g and arrived level at 50,000 ft. The peak Mach number at entry was 2.5. The aircraft was at less than 0.16g for approximately 43 sec. and less than 0.2g for more than a minute. Stabilizer angle required to maintain angle of attack during the entry was 20 deg. out of a 35-deg. angle available.

Maximum-Speed Flight

The maximum-speed flight was made on Aug. 4, three months after Walker's third flight in the X-15. Practice on the flight plan and working out of flight-plan details by use of a ground simulator and landing practice with a Lockheed F-104 proved to be a good substitute for flight in the X-15 itself, Walker said.

Launch from the B-52 was made over Silver Lake at an altitude of 45,000 ft. and at Mach 0.82. During engine start, the angle of attack reached about 10 deg. and the airplane dropped to 38,000 ft. before it began to climb. A relatively large unstable trim change exists between Mach 1.2 and 1.5 but no difficulty was encountered in maintaining an 8-deg. angle-of-attack climb schedule for maximum lift/drag ratio. At 75,000 ft., at Mach 2.2, pushover to zero was initiated and Walker observed that as the angle of attack approached zero a slow lateral oscillation developed. The oscillation tended to reduce in amplitude as the angle of attack and pitching velocity approached zero. At the peak altitude of 80,000 ft., at Mach 2.6, Walker rotated the aircraft to 0.5g and maintained this level for the remainder of the powered flight. A gradual increasing dive angle was obtained during the acceleration to maximum speed. Burnout occurred at 69,000 ft., after the Machmeter had indicated above 3.5. Later, this was corrected downward to 3.31 from internal recordings and radar data.

After burnout, drag data and stability and control data were taken following which his attention was turned to landing the X-15 on the dry lake at Edwards AFB.

Heart Failure Threat to Astronauts

Dayton, Ohio—Cardiovascular failure poses a significant threat to the lives of astronauts, according to Dr. G. Douglas Talbot, heart specialist and cardiovascular consultant to U. S. Air Force.

This threat is of concern to medical men in Project Mercury and will be of even more concern to those associated with later space flight projects, Dr. Talbot told the American Rocket Society conference here on the anatomy of manned-space operation.

Other than failure of the vehicle itself, the combined effect of zero-gravity, accelerations and stress on the human cardiovascular system is perhaps the greatest danger Mercury astronauts will face. Subject of an intensive research program by Air Force, cardiovascular failure promises to become a significantly greater threat to pilots of interplanetary vehicles where the effects of zero-gravity and other factors will be considerably prolonged.

Results of extensive examinations with the newest techniques and equipment available indicate that the Mercury astronauts are free of any signs of cardiovascular trouble. Moreover, Dr. Talbot said it is hoped that the training program devised for these men will keep them free of any disposition to deposit arterial fat or of any other signs pointing to cardiovascular trouble.

Another speaker, Dr. William F. Ashe, professor of aviation and preventive medicine at Ohio State University medical school, reported a potential space flight communications problem. It was accidentally discovered in recent research at Ohio State, Dr. Ashe said, that if a subject—say an astronaut during re-entry—is vibrated at frequencies of 12-30 cps. in amplitudes from 0.1-0.25 in. he can't control the air flow in his trachea and his speech becomes unintelligible.

Dr. Ashe also raised the possibility which was indicated in experimenting with rats that astronauts might be forcibly lulled to sleep, in a manner reminiscent of cradle rocking, if subjected to low frequency' vibrations.

In a report scheduled for the meeting but not presented, The Martin Co.'s Edward C. Wortz said that human error is responsible for 25-30% of all missile system malfunctions reported each month. (Copies of the report, which were available at the start of the conference, were withdrawn later at the request of The Martin Co.)

With better malfunction reporting, Wortz estimated, human error or human-initiated failures probably would show up as the cause of 30-50% of all reported equipment failures and 15-20% of all unscheduled holds. Preliminary results of a remedial program recently undertaken by Martin at its Denver facility indicated that the four most important "probable failure causes" are:

- **Poor workmanship** resulting in condemned items.
- **Failure to follow blueprints,** procedures, specifications, modifications, etc.
- **Incorrect installation** of an item.

Recommendations concerning specific problems uncovered by this program, according to Wortz, have led to equipment redesign and procedural changes which have eliminated a number of costly human-initiated failures.

Eugene B. Konecci, chief of the life sciences section at Douglas Aircraft, discussed the growing importance of human factors in missiles and space systems design. A good example, he told AVIATION WEEK, is his section at Douglas which started out two years ago with three persons and now requires 57. At the present time, eight of his human factors specialists, figured on a time basis, are working on the Skybolt ALBM and four are working on Nike Zeus.

Recently, Konecci's section acquired the responsibility for human factors in transport design, an area for which he sees significant growth potential associated with the development of supersonic and hypersonic transports.

Approximately 110 life science specialists attended the conference, first meeting held by ARS' Technical Committee on Human Factors and Bio-Astronautics.

Japan Plans Space, Satellite Programs

Tokyo—Japan will undertake for the first time various full-scale space projects—including a satellite—in Fiscal 1961 which begins next April. Government has budgeted $3 million for the program.

Japan's Space Development Council, headed by Kankuro Kaneshige, honorary professor at Tokyo University,

Today is obsolete...

The "breakthrough" of every sunrise symbolizes the day-to-day *race with obsolescence* which challenges our nation and its scientific teams. While many achievements today are awe inspiring, no technological group or organization can rest on its laurels in this highly-competitive cold war era.

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has submitted a recommendation to Prime Minister Hayato Ikeda for the promotion of space science and technology.

In his report, Dr. Kanashige urged Ikeda to approve these projects to be undertaken in Fiscal 1961 and 1962:

- **Complete and launch** Kappa 9 type observation rockets, now being designed by Tokyo University's Industrial Science Research Institute, in Fiscal 1961. Kappa 9, carrying 13.2 lb. of observation equipment, is said to be able to attain altitudes of from 186.4 to 249 mi.
- **Start designing** and manufacturing Kappa 10 type rockets which will be capable of reaching the same altitude as Kappa 9, carrying observation equipment weighing from 44 to 66 lb. Sources said a total of 20 Kappa 9s and 10s will be built at a cost of $2-million in Fiscal 1961 and 1962. Observation equipment includes a 16 mm. television camera, radar transmission device, and other measuring instruments.
- **Complete in Fiscal 1961** a parabola antenna, about 99 ft. in diameter, and a receiving apparatus of the Postal Service Ministry's Radio Technology Research Institute in preparation for space communication devices which will be manufactured in 1962.
- **Start manufacturing** meteorological observation rockets and rockoons, which will be capable of reaching maximum 249 mi. in Fiscal 1961 and launch them in the following fiscal year.
- **Begin designing** an artificial satellite in Fiscal 1961 in preparation for such a time when Japan reaches launch capability.

WHAT'S NEW

Publications Received:

Countdown—The Story of Cape Canaveral—William Roy Shelton—Little, Brown and Co., Boston, Mass. $3.50; 185 pp. A book for young people explaining the launching of missiles. Illustrations of rockets and life at Canaveral are included.

Practical Air Navigation—Thoburn C. Lyon, Consultant—Weems System of Navigation, Inc., Annapolis, Md. $4.00; 384 pp. paperbound. The commercial edition of the former Civil Aeronautics Bulletin No. 24. Study guide for all FAA pilot ratings.

Learning to Fly—John H. Holland—Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York 17, N. Y. $5.00; 256 pp. Written in accordance with the latest FAA licensing procedures. Includes instructions for controlling speed, rolling, taxiing, turning, etc.

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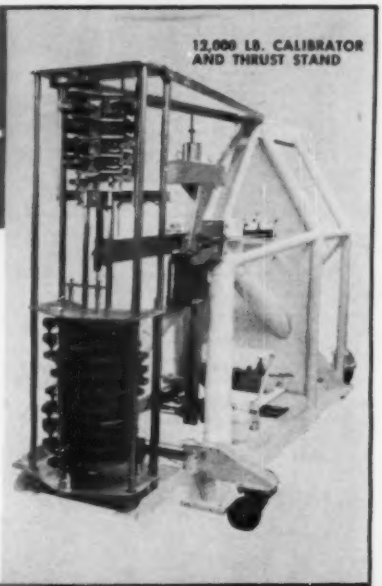

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Siegler selected to produce electronic launch control system for silo-launched ATLAS ICBM

Convair-Astronautics Division of General Dynamics and the U.S. Air Force have selected Siegler for production of the automatic electronic launch control system of the mighty Atlas. Production is now in progress under a major multi-division contract awarded The Siegler Corporation.

The Siegler team in this top-priority project includes Siegler's Hallamore, Hufford, and Magnetic Amplifiers divisions.

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ICBM Base Program Regaining Lost Time

By Larry Booda

Washington—Intercontinental ballistic missile site activation program appears to be regaining lost time after suffering growing pains which hit the Air Force, Army, Defense Department, missile contractors, construction firms and labor unions.

Major efforts to ease construction and activation problems have been made since they became acute last spring. These efforts included meetings between Defense Secretary Thomas S. Gates and contractors in July and labor leaders in September. These meetings inspired a greater sense of urgency in contractors and labor leaders and focused attention on the need for central management on the military side.

Management Roadblocks

As a result, major management roadblocks appear to have been overcome and relatively harmonious project relationships have developed as administrative procedures have been changed and management teams have been reorganized (AW Aug. 1, p. 26).

Scope of the base activation problem was described recently by Maj. Gen. Thomas P. Gerrity, who was installed as commander of Ballistic Missile Center last summer with the task of solving the problem. He said:

"The marriage of precision equipment with a heavy concrete and steel structure so that the two will work as a single unit has caused problems that were largely unpredicted. The numbers and types of people required on site have exceeded our expectations by as many as five times. What once was considered a relatively simple job of hooking together a few pieces of equipment and pushing the button to see that it worked has turned into something of a monster. We can lick this monster if we reorganize and respect it for what it is and gear our efforts accordingly.

"Each of our 17 bases has different management teams, and each team has different workers. The problem is to establish an effective learning curve under these circumstances. In the factory, one management-production team learns by performing repetitiously the same operation on succeeding production units.

"Because of compressed schedules in the site activation program, little opportunity exists to move management and workers from site to site and establish a learning curve in this manner. Therefore, we must develop new and more effective methods to transfer know-how gained on earlier bases to those sites to be activated at a later date."

Differing Ideas

Although the Army Corps of Engineers and general contractors have a large pool of experience to draw upon for base construction, the missile site activation program caught this team between an accelerated program of great magnitude required by an Air Force, which was relatively inexperienced in making specifications and in some instances undecided on them, and prime missile manufacturers with differing ideas on how best to achieve activation.

The construction contractors were confronted with conditions unfamiliar to them with their background in building bridges, tunnels, industrial plants and buildings—mainly in the area of close tolerances and equipment cleanliness.

Labor added its share to the problem by indulging in jurisdictional disputes

Avro Blue Steel in Production

One of the first production series of the Avro Blue Steel air-to-surface weapon system is shown on missile carrier in front of an Avro Vulcan B, on which the missile will be mounted. Supersonic Blue Steel carries nuclear warhead, is powered by a two-chambered Bristol Siddeley Stentor rocket engine (AW Sept. 12, p. 30).

between craft and industrial unions and with even more highly complex disagreements between craft unions, due mainly to attempts by general construction contractors to move in on technical jobs (AW Oct. 3, p. 29).

Rate of Progress

At this point, the construction program is about one tenth complete. From a current level of $400 million a year, the rate of spending will rapidly go to about $1 billion in Fiscal 1962 for site construction and activation. Completion date is 1965. The Atlas program is well under way. Early Atlases will lie in semi-hard "coffins" before being raised for firing, and later bases will have them buried in silos but raised to the surface for launching. Titan I missiles will have a similar silo arrangement.

Titan II missiles will be fired directly from their silos.

Atlas operational bases have been completed at Vandenberg AFB, Calif., and at Warren AFB, Wyo. Like the Titan II, the solid-fueled Minuteman will be fired from underground silos.

First move in trying to overcome slippage in construction timetables was made late last year when the Air Force set up the Anderson Board, headed by Air Materiel Command Commander Gen. S. E. Anderson. Completing its work four months later, the board recommended several steps to be taken to speed the work.

First concrete result of the survey came when the Corps of Engineers Ballistic Missile Construction Office was created Aug. 2 with headquarters in Los Angeles in the same building with the Ballistic Missile Center of the Air Materiel Command, which took over management of ICBM site actuation in July. CEBMCO was put under Brig. Gen. A. C. Welling, former Engineer Commissioner of the District of Columbia, and made solely responsible for construction program contract administration.

Since then, projects have been turned over to Welling's office from Corps of Engineers Districts where they formerly had been administered. The shift was scheduled to be completed in November.

At the same time, the Ballistic Missile Center, under Gen. Gerrity, became the central clearing house for the Air Force, integrating the functions of the Air Force Civil Engineering Directorate, missile contractors, equipment contractors, and the Ballistic Missile Division of the Air Research and Development Command.

ARDC Role

Prior to the transfer of central control to BMC, the site activation function belonged to the Ballistic Missile Division of the Air Research and Development Command, which kept it until time to turn the bases over to the Strategic Air Command. Now ARDC chooses the site and BMC supervises such site activation factors as construction, installation and checkout of the system, and adherence to specifications. In order to permit ARDC to prove out systems and generate changes, the command has retained control over the activation of the Vandenberg AFB, Calif., base, sites one and two at Warren AFB and Offutt AFB, Neb.

In the July 29 conference with Gates, the contractors presented a list of complaints and suggestions which were studied by the Defense Department. Late in September, action on these recommendations was announced.

Principal complaint of the general contractors was too many bosses. They suggested that, since their contracts were with the Corps of Engineers, the Army have sole control of construction. Establishment of CEBMCO and its contracting officer as the single authority to deal with a contractor has answered this complaint to the satisfaction of the contractors.

Another source of irritation was soil, water and other conditions of sites selected. It was claimed that many were located in heavy water or rock condi-

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tions, when suitable sites were only a short distance away. One example given was a complex with launching sites in three states, causing the contractor to deal with three sets of state laws.

Defense replied that site selection is an optimum combination of factors such as separation distances, location and density of populated areas, accessibility for continued support, and soil composition. In some instances, criteria have been relaxed, but all are under constant review.

Data Was Available

It was pointed out that test borings and geological and weather condition reports were available to contractors before bidding and that if conditions were different from those submitted, contract modification machinery was set up to handle such situations.

With site construction going on at the same time as the development program, change orders became a problem. These orders were a result of changing requirements as the missile systems developed. With every firing of an Atlas, the construction contractors claimed, they received a mass of change orders. They asked for a reduction in the number of these orders and the authority to propose alternate methods of accomplishing their purpose. Centralized management of the program was offered as a solution to this suggestion.

Another source of contractor unhappiness was multiple inspections. Not only did these inspection teams take valuable time, but they produced contradicting orders. Although there is now a central inspection procedure, there still are separate inspection teams representing the principal parties interested in site activation. But these sub teams do not give orders—they forward them to the central authority.

Closely related to inspection are measurement tolerances and purity, or cleanliness, criteria. Contractors, except for those involved previously in chemical plant construction, were not

Small Missile

Washington—Renewed interest is being generated in Air Force and Army headquarters for a small, mobile, solid-propellant, tactical ballistic missile (TBM) with a range up to 1,200 mi. Possible use would be in foreign theaters of operations, where roads are relatively narrow and bridges are light. The missile would have a weight limit of about 10,000 lb. The project would find some precedent in an in-house study made at Air Force's Ballistic Missile Division about a year ago, from which no specific hardware materialized.

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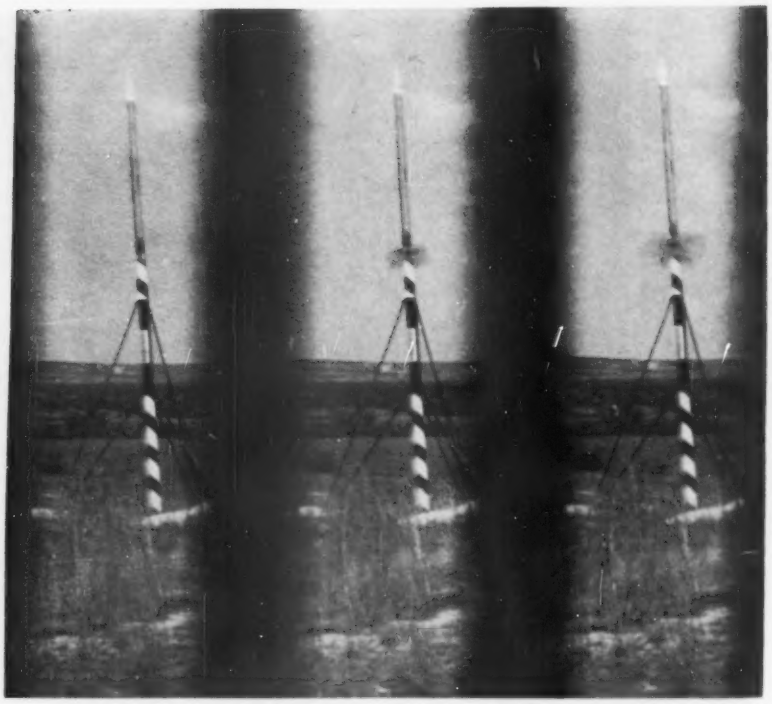


Rocketdyne Tests New Sounding Rocket

First two test launches of Rocketdyne solid-propellant sounding rocket (AW Sept. 12, p. 97) have been conducted successfully at Ft. Hood, Tex., in a 16-mph. wind, both vehicles climbing to 3,000 ft. and then impacting within 100 ft. of each other. Tests were conducted using short-duration propellant grains; with full-duration ammonium nitrate propellants, the vehicle is designed to carry a six-pound payload to 230,000 ft. Primary purpose of Ft. Hood trials was to check stability of the rocket as it left the launcher tube, which also serves as a shipping container. Photo sequence highlights tight seal of rocket in tube when fired; motor smoke is absent until the rocket leaves tube (center photo). Initial test firings were made using a steel prototype of the reinforced plastic launching tube. Sounding rocket system was designed, built by Rocketdyne's Solid Propulsion Operations.

familiar with the meticulous standards required for cryogenic storage and transmission systems. These standards specified that only particles of micron size could be tolerated and that the metal parts in the systems must be capable of withstanding a substantial range of temperatures.

Problems and Solutions

Other contractor recommendations and Pentagon actions included the following:

• **Stationing of an architect-engineer** representative at each site to expedite approval of shop drawings. This has been done.

• **Continue the competitive bid,** firm price type of contract, awarded to the lowest qualified bidder. The general contractors, accustomed to competitive bidding, prefer this over the negotiated contract with its fixed fee. In the overlap period when a general contractor is finishing his job and the missile contractor comes in to complete the missile launching installation, the differences in operating procedures became a source of irritation because the missile producers operate on fixed fee contracts, and, according to the general contractors, do not practice economy to as great an extent, affecting construction employe morale.

• **Combine site activation** program construction and mechanical contracts, which originally were made separately. This has been done.

• **Accelerate payments** to be made after change orders were made in contracts. Contractors complained that the payments were slow in coming. A two step system was installed, providing for a minimum payment immediately and negotiation for the entire cost in the second step.

• **Greater use of contractor** equipment. Air Force argued that to achieve the degree of standardization needed, the amount of government-furnished equipment could not be reduced.

Contractor Competence

In the rush to complete the bases, it was noted that some contractors were plunged into situations beyond the capabilities of their organizations. Although there were no completely unqualified bidders, it soon became apparent that there were many degrees of competence among the contractors and that a screening system was necessary.

Not only will the prime bidders be screened, but subcontractors will also come under scrutiny because the failure of one could throw off a whole construction schedule. Capital resources, performance record, current workload, and managerial and technical qualifications will be considered. Joint ventures will be permitted.

Program Forecast

With the establishment of central control, many of the contractors' complaints have been answered, and the site activation program has been speeded to the point that the time formerly lost has been made up and the Air Force anticipates that the program soon will be ahead of schedule.

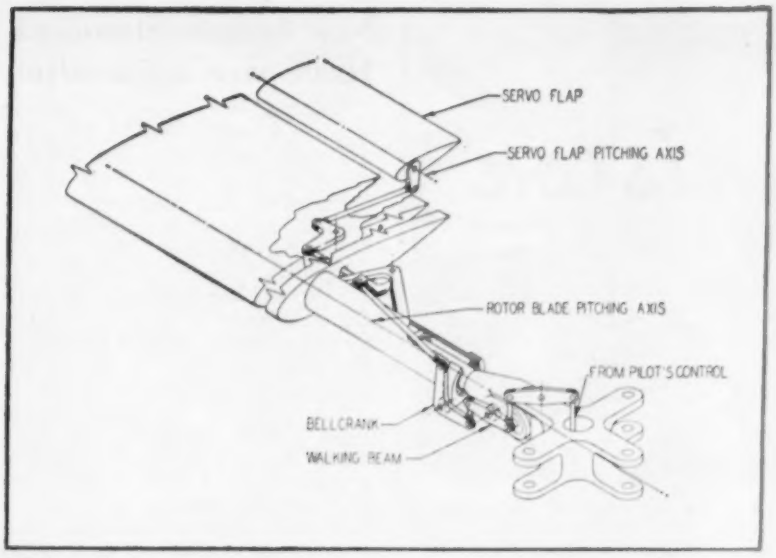
With labor leaders having indicated that they would keep labor's house in order and contractors satisfied with the adjustments made in contractual relationships through having one agency responsible for general contracts, the Air Force now believes that the "show is on the road." One official stated that after the kinks have been ironed out of the first few installations, the missile program would proceed at a pace which would see the nation's ballistic missile deterrent power at a potent level within a year.

AF Transfers Missile Functions to Norton

Washington—Air Force is transferring some elements of its Ballistic Missile Division and Ballistic Missile Center to Norton AFB, Calif. to provide more room for space activities at the BMD-BMC facilities in Inglewood, Calif.

USAF is transferring ICBM site activation functions and certain other ballistic missile functions to Norton, but missile and space system research and development functions will remain at BMD in Inglewood. About 100 BMC and BMD personnel will be moved to Norton initially, with more to follow next year.

Under the BMC transfer schedule, the advance party and site activation group will move between Nov. 1 and Dec. 15; Atlas weapon system functions, plus other functions and personnel will move between Dec. 15 and Feb. 1; Titan I functions, plus other functional and staff personnel will be shifted Apr. 1-May 15; personnel in the office of the commander and other staff officers to be transferred are to complete their move by June 30, and all Titan II and Minuteman functions are to be moved in 1962.



PITCH feedback control linkage resists blade gust load forces on Kaman HU2K-1.

HU2K Flap Linkage Cuts Blade Loads

Aerodynamically actuated pitch feedback control in the servo flap linkage of the Kaman HU2K-1 Navy utility helicopter reduces flap loads and profile power requirements for increased speed and range.

The pitch control system on the HU2K Seasprite is made necessary by increased cyclic and collective pitch range on the high-speed vehicle. The control linkage resists sudden gust loads on the blade by exerting opposite forces to return the blade to the command setting. Mechanical spring forces are not employed to stabilize the blade.

The pitch feedback control incorporates a walking beam attached to, and pivoting on, the rotor hub which rotates but does not pitch with the servo flap controlled blade. Mechanical linkage to the flight controls permits the pilot to set the walking beam for the required pitch setting. A bell crank linked to the walking beam pivots on the rotor blade and continues the pilot's control command to the servo flap.

This control linkage forces the bell crank to rotate with respect to the walking beam in the event an air gust or other disturbance causes the rotor blade to twist. In doing this, the bell crank causes the remaining control linkages to move the servo flap in the correcting direction. The pilot controls the centering point of blade pitch and the aerodynamic spring restores the disturbed blade to its center position.

The aerodynamic spring permits the servo-flap to operate at lower total lift levels, reducing stresses in the flap and supporting structure and in the portions of the blade influenced by the flap structural attachment. Kaman says that the pitch feedback rotor control system saves power, reduces vibration levels and alleviates blade tip stall at high speeds. Another advantage cited for the system is that flap loads remain proportional to blade loads as altitude is increased, making the feedback control effective throughout the HU2K's altitude range.

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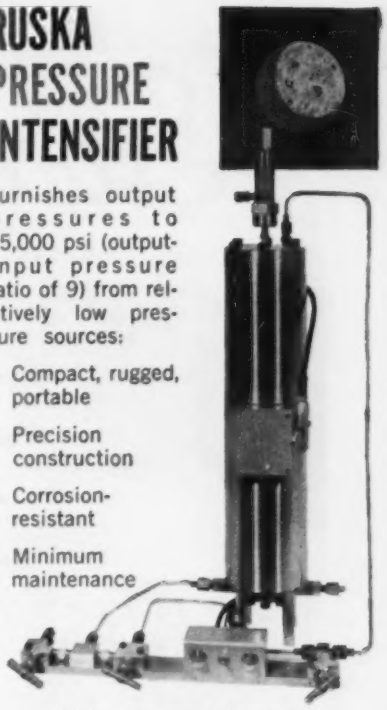

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PROBLEMATICAL RECREATIONS 38

Seven singular scientists shared a grindstone the diameter of which was sixty inches. What part of the diameter was the rightful share of each singular scientist? Assume that each grinds his share sequentially. —*Ladies Diary, 1709*

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New Length Standard Has Space Application

Adoption of a new international standard of length (AW Oct. 24, p. 34) will make it possible to check measurements to an accuracy of one 10-millionth of an inch, compared with the previous millionth standard—platinum-iridium bar—used since 1889.

Eleventh General Conference of Weights and Measures has agreed to redefine the meter as 1,550,763.73 wavelengths of orange-red light emitted by the isotope krypton 86, making the more precise measurement possible.

The conference also adopted an interim standard for the second, establishing the basic unit as the length of a second on Jan. 1, 1900, at zero hours. This eventually will be replaced by a time unit based on oscillation of a cesium atom. A time unit based on the earth's revolution, which varies, no longer is adequate for the space age, scientists at the conference agreed.

Long-range implications of the new standard of length are tremendous, according to Louis Polk, president of Sheffield Corp., a subsidiary of Bendix Corp., and one of the U.S. delegates. In a moon shot, for example, Polk pointed out, misalignment of a millionth of an inch would cause a miss.

Polk added that the krypton 86 standard makes it possible for anyone who needs to split millionths to have a standard in his own laboratory, take close-tolerance measurements that can be repeated anywhere in the world. Measurements on a 4-in. block recently circulated among Great Britain, Germany and the U.S. were identical to a 10-millionth, using a krypton source.

Riddle Buys 7 DC-7s To Improve Service

Miami, Fla.—Seven Douglas DC-7Cs which Riddle Airlines is acquiring from General Aircraft Leasing Division of General Dynamics Corp. will be used to upgrade Riddle's DC-4 and C-46 service between Miami, New York and San Juan, Puerto Rico.

Riddle acquired the DC-7Cs for $750,000 each in a $9 million package purchase (AW Oct. 10, p. 34). Spare parts ordered with each aircraft cost an additional $1.4 million.

Riddle's contract with Douglas Aircraft, which won a $2.1 million contract to convert the DC-7s to freighter configuration in competition with Lockheed Aircraft Service (AW Oct. 3, p. 52), calls for delivery of two aircraft in November and two in December; two already have been delivered.

Formerly owned by Scandinavian Airlines System and Swissair, the DC-7s,

with interiors rapidly convertible for freight or charter passenger operation, initially will be used to upgrade Riddle's DC-4 and C-46 service between Miami, New York and San Juan, Puerto Rico.

The all-cargo line, which now is seeking a Civil Reserve Air Fleet contract, will bid the DC-7s in an effort to capture sizable Military Air Transport Service contracts effective through next year. For MATS and transatlantic charter operations, Riddle has specified 99-seat interiors for the new aircraft.

Although failure rate for Wright R3350 Turbo Compound engines used on the DC-7C generally has exceeded that of comparable size powerplants, Riddle feels that it can operate the engine-airframe combination profitably and reliably by stressing economical cruise power settings. Engineering teams from Curtiss-Wright have aided Riddle in this project.

Riddle also holds that one big factor behind the engine's shortcomings has been trunkline speed racing of DC-7s over highly competitive route segments.

Dassault Mirage III Crashes at Low Altitude

Dassault Mirage III crashed near Paris during a high-speed low-altitude training flight, killing the French air force test pilot. Accident happened while the pilot was executing a series of rolls at 400 kt. at an altitude of less than 300 ft. Accident marks the first Mirage III crash after more than 1,000 hr. of flight. Aircraft involved was preproduction Model 05.

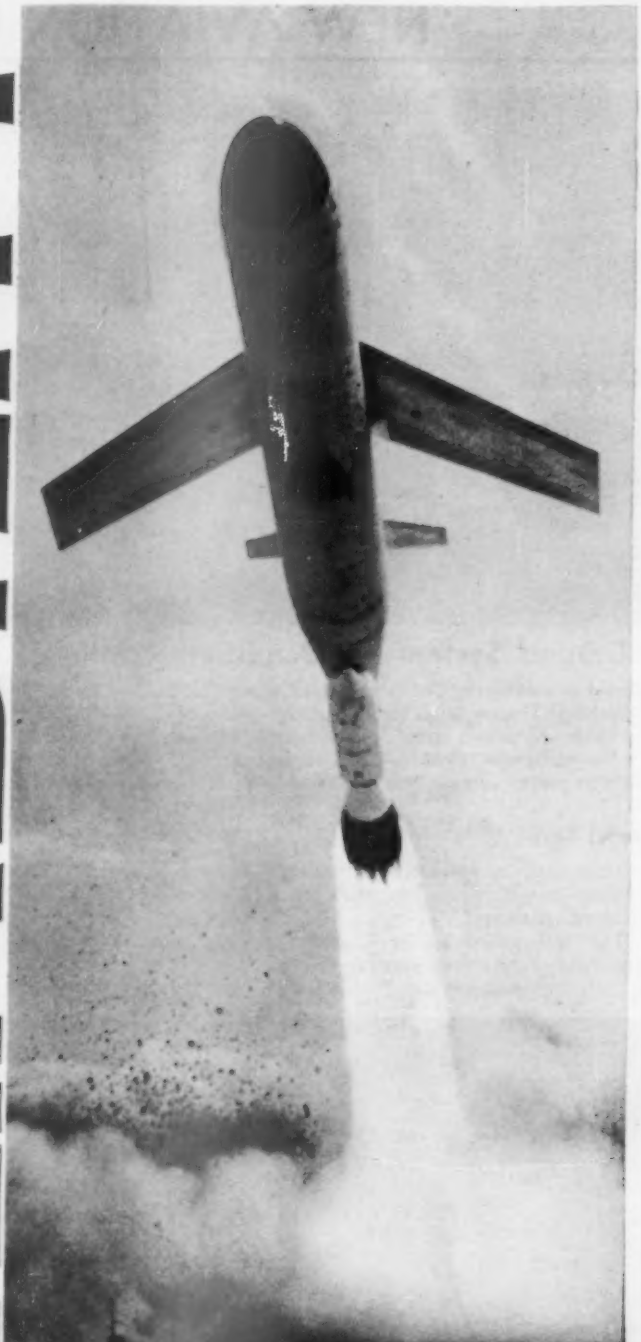
PRODUCTION BRIEFING

General Electric Ordnance Department has received Navy contracts of more than $4.4 million for production of Tartar fire control directors, manufacture of Mark 44 torpedo sea water batteries, and development and prototype fabrication of Mk. 44 Mod. 1 torpedoes for Asroc anti-submarine missile system.

North American Aviation's Columbus Division is testing a rocket-powered ejection seat for VTOL aircraft that is expected to permit safe ejection at no forward speed from ground level to 10,000 ft.

Astro-Space Laboratories, Inc., a subsidiary of Belock Instrument Corp., New York, has opened a $1 million research and development facility at Huntsville, Ala. Astro-Space will specialize in guidance and control systems for missile and space vehicles, stabilization systems, navigational equipment, ground support equipment and medical electronic instrumentation.

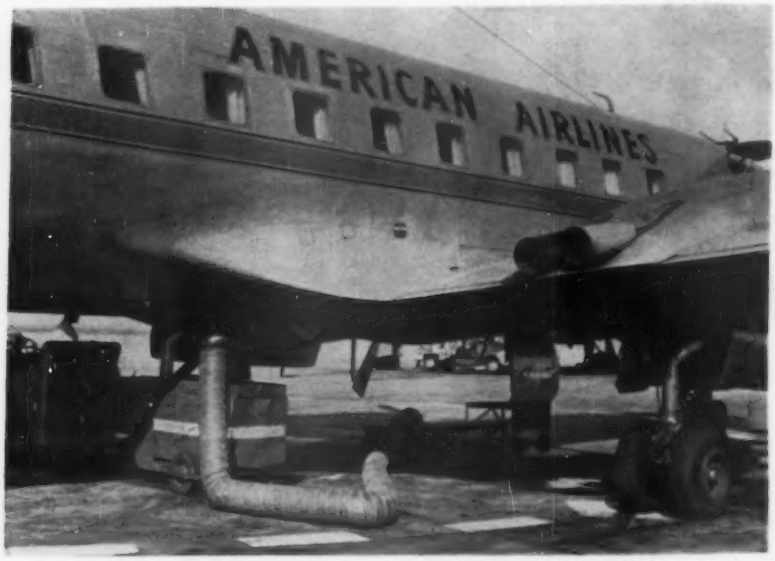
RELIABILITY



Air Force-Martin Mace B, 1200-mile inertial guidance tactical missile, incorporates the proven basic design of Matador and Mace A—operational missiles with outstanding records of years of reliable front-line service.

MARTIN

NEW AVIATION PRODUCTS



Ground System Air-Conditions Parked Aircraft

Central air-conditioning system at Amon Carter Field, Ft. Worth, Tex., provides ground cooling for a Convair 240. The hydrant-type system eliminates the need for air-conditioning trucks and ground operation of aircraft cooling systems. Flexible tubes installed at 19 loading stations extend to 32 ft. to duct the 60F cooling air. The vinyl-protected ducts are produced by the Flexible Tubing Corp., Guilford, Conn.

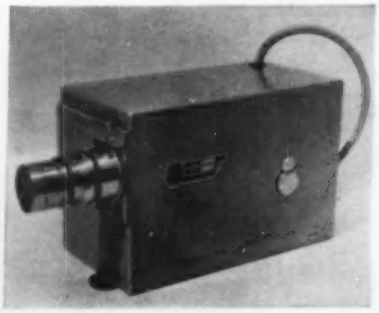
Metal Seal

Metal seal is intended for sealing applications which experience wide temperature variations.

The seal, called Bar-X, is said to withstand temperatures from −450 to 1,200F and peak pressures of 40,000

psi. The "X" configuration seal, reported to provide elastic deflections and high sealing forces, has provided zero leakage from room temperature to 1,000F with dry nitrogen at 1,000 psi. in a static seal application.

Wiggins Connectors, 3424 E. Olympic Blvd., Los Angeles 23, Calif.



Flight Test Camera

Structural stress and wing movements during flight of the North American X-15 are filmed with two 16mm. cameras. Other applications include missile and satellite testing.

The camera measures 7 in. long, 4 in. wide and weighs 8 lb. Equipped with a pulse-cine mechanism, the camera records the stress changes on film at a predetermined number of frames per second to record the minutest changes in wing surface stress.

Vought Camera Co., Beverly Hills, Calif.

Executive Aircraft Generator

Generator for business aircraft provides 100 amp. of direct current at engine speeds from 3,000 to 8,500 rpm. The unit will be on all new Aero Commander 560F and 680F aircraft and will be available for retrofit.

The Model 30059 generator, rated at 100 amp., 30 v., is intended to handle increased electrical loads and to eliminate the necessity of carrying high engine rpm. for radio communication while taxiing. The weight of the generator is 30 lb.

Jack & Heintz, Inc., Box 6917, Cleveland 1, Ohio.

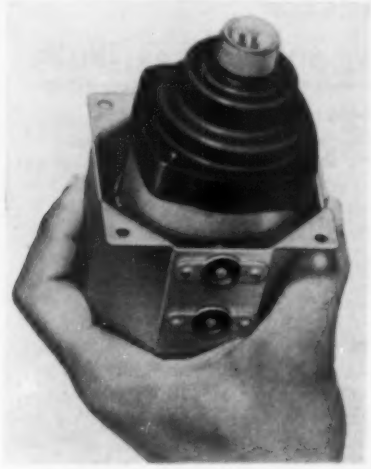
Ground Power Truck

Self-propelled ground power unit is designed to supply electrical power to transport aircraft. The power unit is under evaluation at Idlewild Airport.

The Hobart Model 3163, powered

by a GMC Diesel engine, is rated at 125 kva, 0.8 psf, three phase, four wire, 400 cps. The enclosed control cab is 71 in. high. Noise levels are reduced by the use of a centrifugal blower and two mufflers.

Motor Generator Corp., Troy, N. Y.



Vibration Mount

Vibration isolation mount is intended for small equipment and instruments on jet aircraft.

The elastomeric mount is said to provide all-attitude protection against high-frequency excitation. A typical mount, the BL-1705, weighs 0.38 lb., supports a pressure transducer weighing 1.2 lb. The system incorporates

four Multiplane mountings in a center-of-gravity suspension which protects from vibration from −65 to +300F. Natural frequency is 45 cps.

Lord Manufacturing Co., Erie, Pa.

High Pressure Bleed Valve

Valve to blowdown high pressure gas or hydraulic systems is intended for bleeding high pressure reservoirs in missile control systems and bleed or shutoff of high pressure air systems in aircraft.

The P-416 valve has an operating pressure range of 0 to 3,000 psi., temperature range is −65 to +300F, weight is 0.06 lb. Flow rate of the valve is from 40 to 60 cfm. at 3,000 psi. pressure. Valve is of chromic anodized aluminum construction.

James, Pond & Clark, Inc., Pasadena.

Phillips Designs Underwing Fuel Trucks

Jet fuel trucks at Stapleton Field, Denver, Colo., are modified to fuel either Boeing 707 or Douglas DC-8 jet transports. Continental Airlines Boeing 707 (above) is fueled by two trucks spotted at the aircraft's wingtips. United Air Lines Douglas DC-8s (below) receive underwing fueling from trucks spotted between engine pods on both wings. Trucks were designed by Phillips Petroleum, the fuel supplier. Capacity is 17,600 gal., which can be pumped at a 600 gpm. rate.

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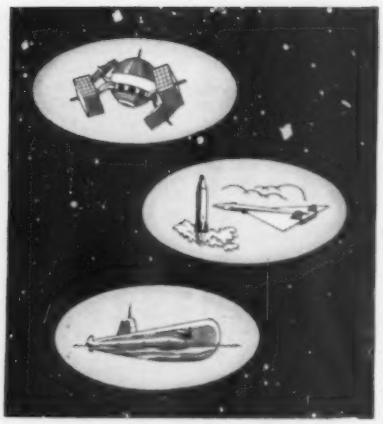

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FINANCIAL

Financial Briefs

Control Data Corp. earnings for Fiscal 1960 were $551,686 on sales of $9,665,290, compared with earnings of $283,214 on sales of $4,588,174 for the previous year.

Atlantic Research Corp. earnings for the six months ended June 30 were $329,482 on sales of $5,985,215. This compares with the previous year's first-half earnings of $196,895 on sales of $3,429,010.

Siegler Corp. earnings for the year ended June 30 were $3,201,023 on consolidated sales of $84,095,002, compared with earnings of $2,203,022 on sales of $77,074,442.

Aerojet-General Corp. reported earnings of $6,757,803 for the nine month period ending Aug. 31, an increase of 12% over the comparable period of 1959. Sales increased 20% to $308,375,504. Earnings per share of common stock increased 13 cents to $1.47.

Ethiopian Air Lines reported net profit for 1959 of $296,788 compared with last year's net of $54,197. Operating revenues for 1959 totaled $8.1 million and operating expenses $7.5 million compared with last year's figures of $6.1 million and $5.9 million respectively.

Dividend increase of 25% by Cessna Aircraft Co. increases annual payment to stockholders from 80 cents to $1.00 per share, with the first dividend at the higher rate of 25 cents being payable Nov. 17 to shareholders of record Nov. 1. This is the fourth dividend increase by Cessna in the past two years. President Dwane Wallace says that unaudited figures indicate total sales of more than $103 million for the fiscal year ended Sept. 30, down from last year's $105,786,000, with the drop attributed to lower military, agricultural and industrial hydraulics business. Commercial plane sales reached about $56 million, a 20% increase. Wallace says that the outlook for 1961 looks better than 1960 in volume and profits.

Venture capital investing can show some spectacular paper profits in individual cases, although these might be offset by losses on others. American Research and Development, a Boston-based investment group, saw its 33,637 shares of High Voltage Engineering Co. rise in value from $65,271 when purchased to $4,654,519 at the end of the first half of 1960. High Voltage builds particle accelerators and is active

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For more information please write to: Mr. A. K. Bowman, Engineering Personnel, North American Aviation, Inc., Los Angeles 45, California.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

in the electrostatic propulsion research field.

Problem with such profits, based on the over-the-counter stock market bid quotation for the shares, is that sale of such a large bloc of the stock might bring a price under this figure. Such stocks can be volatile as well. American Research bought 10,000 shares of Itek Corp., also a Boston company in the information retrieval field (AW Dec. 7, p. 109), for $440,000 during the first half, saw the value rise to $775,000 at mid-year, then drop back to $500,000 during the pre-election market decline.

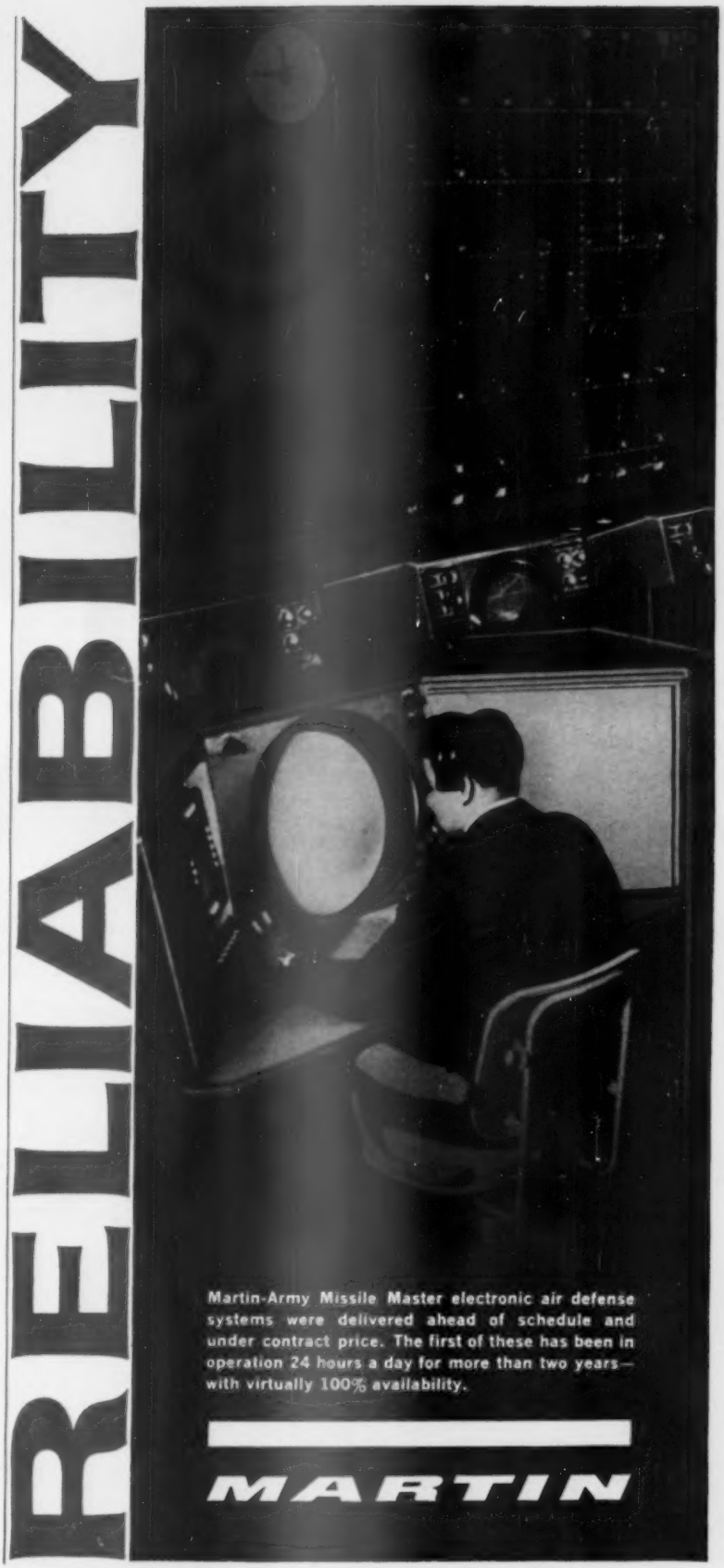
United Air Lines has declared a quarterly dividend of 12½ cents per common share, as well as a 3% stock dividend, payable Dec. 15 to stockholders of record Nov. 15.

Westinghouse earnings for the nine months ended Sept. 30 were $60,680,000 on sales of $1,457,233,000 compared with earnings of $56,225,000 on sales of $1,408,393,000 for the first nine months of 1959.

New Offerings

Technical Measurement Corp., North Haven, Conn., which was organized pursuant to Delaware law on June 28, 1960, and on June 30 acquired all the outstanding stock of a Connecticut corporation of the same name from R. M. Ghen, president, and D. S. Davidson, L. Henthorn, and C. F. Hewitt, officers, who received all the outstanding 480,000 common and 1,876 preferred shares of the new company in exchange for their holdings of the predecessor's common preferred shares; business involves the manufacture and sale of electronic equipment principally multi-channel, digital computers. Offering is 120,000 shares of common stock for public sale at $5 per share. Proceeds will be used to repay outstanding bank loans, to purchase about $75,000 of equipment and fixtures for its engineering laboratory, its printed circuit department and machine shop to expand the company's research and development program at an estimated cost of $80,000, and to supplement working capital.

Federal Pacific Electric Co., Newark, N. J., engaged primarily in the business of manufacturing and selling devices for the distribution and control of electric energy, including standard low tension equipment such as circuit breakers, safety switches, panel boards, fuses and fuse boxes. Offering is 377,000 shares of common stock and 45,000 outstanding shares of 5¼% convertible second preferred series A stock. Of the common stock, 250,000 shares are to be offered for public sale by the company;


RELIABILITY
Martin-Army Missile Master electronic air defense systems were delivered ahead of schedule and under contract price. The first of these has been in operation 24 hours a day for more than two years—with virtually 100% availability.
MARTIN

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Aviation Week

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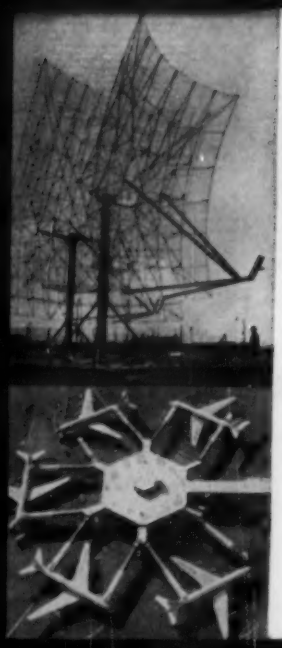

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PUBLISHING DATE: Mid-December

CLOSING DATE: November 15, 1960

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Aviation Week and **Space Technology**

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offering price and underwriting terms to be supplied by amendment. The additional 127,000 common shares represent part of the consideration being paid by the company for all the outstanding common stock of Pioneer Electric, Ltd., (a Canadian company) from its sole common stockholders. Proceeds of the sale of the 250,000 common shares will be applied toward supplying the cash consideration for the purchase of the Pioneer stock; the balance to retire short term bank loans and for working capital.

Gulton Industries, Inc., Metuchen, N. J., engaged in the research, development and manufacture of electronic, electro-mechanical and electro-acoustic components, instruments and equipment which are sold to the military and to commercial manufacturers. Offering is 100,000 shares of common stock for public sale; offering price and underwriting terms to be supplied by amendment. Proceeds will be added to the company's general funds and in large part initially will be invested in short term government securities; thereafter, funds will be available as additional working capital for the carrying of inventories and accounts receivable. In addition, the company intends to apply a substantial portion of such proceeds to the acquisition of related and complementary businesses. The company recently acquired a 67% interest in Systems Research Group, Inc., Mineola, N. Y., and has contracted to purchase the remaining 33% interest, the total purchase price being $150,000 plus payments over the next three years in company stock.

Lithium Corporation of America, Inc., New York, N. Y.; principal business, the production and sale of lithium metal and lithium compounds; principal sales and research efforts, the development of new markets and new uses for such products. Recently the company has extended its business into various phases of rocketry and aviation. Offering is $2,300,000 of convertible subordinated debentures, due 1970, for public sale; interest rate, offering price and underwriting terms to be supplied by amendment. First, however, the new debentures will be offered in exchange for $925,000 of outstanding 5% convertible debentures maturing in 1964. Proceeds remaining after disposition of the debentures due 1964 will be used as follows: $75,000 for construction of facilities to be used in production of butyllithium and other organolithium compounds; $125,000 for purchase of mining equipment to reactivate the company's North Carolina mining operations; the balance for liquidation of bank debt and replacement of working capital.

RELIABILITY
Navy and Air Force Bullpup/A.F. GAM-83 has been called by the Navy "the world's most reliable guided missile." It is so test-free it can be handled as an ordinary round of ammunition.
MARTIN

CAB Accident Investigation Report:

Fuel Starvation Causes C-54 to Crash

At approximately 2105 EDT., Oct. 15, 1959, a U.S. Overseas Airlines C-54G, N 4000A, a cargo flight, was ditched in a small lake, caught fire, and sank in 10 ft. of water approximately eight minutes after takeoff from the U. S. Naval Air Station, Jacksonville, Florida. The two pilots, the only occupants, were seriously injured.

U. S. Overseas Airlines, Inc., operates both 6- and 8-fuel-tank C-54s, which have different fuel selector positions. The 6-tank system has a 2-position wing tank selector; the main tank positions are forward and the off positions are rearward. The 8-tank fuel system, which N 4000A had, has three tank selector positions; the auxiliary tank positions are forward, the main tank positions are center, and the off positions are rearward.

The accident was caused by fuel exhaustion due to the inadvertent positioning, prior to takeoff, of the four fuel selectors to the nearly empty auxiliary tanks. During the four or more minutes that power was being lost, first on the No. 4 engine, then No. 3, then No. 2, the crew made no effort to reposition the fuel selectors to the full main tanks.

As a result of this accident the company has blocked off the No. 2 and No. 3 tank selectors from the auxiliary positions on all 8-tank aircraft. Also, a large placard has been placed directly in front of the fuel tank selectors in all C-54 aircraft, stating whether the aircraft has a 6- or 8-tank fuel system. The C-54 checklist has also been revised to require a response after MAIN TANKS of "Full Forward" on the 6-tank system, and "Center Position" on the 8-tank system.

Investigation

N 4000A was engaged in a "Quicktrans" scheduled U. S. Navy contract cargo flight which originated in Oakland, Calif., the previous day. Captain Jewell Reid and Copilot Gorden Cole were scheduled to make the flight from Jacksonville to MCAS Cherry Point, N. C., with a stop at Charleston, S. C.

N 4000A, flown by a different crew, arrived at Jacksonville NAS from Dallas at 1750.[1] The two new crew members arrived for duty at 1800. The copilot completed the military form 175 flight plan and the weight and balance record. The captain was briefed on the weather and conducted the aircraft preflight check. The aircraft was being refueled at the time of the preflight check. Approximately 10 min. later the captain drained the fuel tank sumps onto the ramp and observed no evidence of fuel contamination. The captain then required that some of the cargo tiedowns be retied. The gross weight at takeoff was 66,501 lb., 7,299 lb. under the allowable maximum gross weight.

The IFR flight plan was direct to Jacksonville via Victor Airway 3 to Ritter intersection and Victor Airway 185 to Charleston with Norfolk, Va., as the alternate airport. Jacksonville weather at departure was broken clouds at 2,500 ft., 10,000 ft. overcast; visibility three mi. in fog and smoke.

The preflight engine start, engine runup, and the takeoff at 2057 on runway 090 were normal. The Jacksonville-Imeson Airport departure control cleared the flight direct Jacksonville, Victor 3 to Brunswick, Ga., maintain 5,000 ft., climb on runway heading to 1,500 ft. until further advised.

The crew stated that following takeoff the gear retraction, power reduction, flap retraction, and radio communications were routine. Upon reaching approximately 1,400 ft. altitude the No. 4 engine surged. No. 4 throttle was retarded and again advanced but surging continued and the manifold pressure fell off. A check of the instrument panel revealed that all instruments were normal except the No. 4 fuel pressure and fuel flow which fluctuated. No fuel warning light was observed. The use of carburetor heat and selection of the low and high fuel booster pumps did not improve the conditions.

At 2101, N 4000A advised the FAA Imeson Airport departure control at Jacksonville it was having trouble with No. 4 engine and requested permission to circle east of Jacksonville Naval Air Station at 1,500 ft. This was approved. At 2103, N 4000A requested a radar vector back to Jacksonville Naval Air Station. The pilot was instructed to turn to a heading of 275 deg. Subsequently, the following clearance was given to N 4000A: Cleared to Navy Jacksonville low frequency range, maintain 1,500 ft., stand by this frequency. Neither the clearance nor the radar heading was acknowledged by the pilot. At 2105 the radar blip of N 4000A disappeared below the horizontal capabilities of the Imeson Airport departure control radarscope.

Following loss of No. 4 engine, the pilot initiated a left turn towards the 275-deg. heading suggested by departure control. During the turn the No. 4 cylinder head temperature decreased; the cowl flaps were then closed, and the captain had just decided to feather the propeller when the No. 3 engine began to surge. Feathering of No. 4 propeller was deferred and the captain called for METO power instead. This power could not be obtained as No. 3 engine continued to surge. Approximately five seconds later No. 2 engine began surging. During the emergency the copilot stated, "I think we must have taken on jet fuel. It acts like a C-46 did when they were given jet fuel." During this time the copilot reached over and checked the position of the fuel selectors but the captain does not remember whether they were moved from their positions.

The flight crew did not notice the engine instrument readings after the No. 4 engine difficulty nor did they notice whether there was a loss of power from No. 1 engine.

The aircraft was descending rapidly and an attempt was made to ditch on a small lake directly ahead. Several trees were struck in the attempt and the aircraft hit the water, wings level and in a tail-low attitude, on a heading of 25 deg.

The aircraft came to rest on a 290-deg. magnetic heading in 10 ft. of water approximately 300 ft. from the lake's western shore and 280 ft. from its southern shore, with approximately 80% of the fuselage submerged. Fire consumed the upper fuselage down to the top window line between fuselage stations 129 to 621.

Wreckage Examined

Sections and small pieces of the left and right wings, including the ailerons, and pieces of the left and right stabilizers were found strewn along the approach path. All four separated propellers were in the shallow water near the lake's southern shore on and to the right of the approach path centerline.

Investigation of the aircraft, prior to moving the wreckage, revealed that the fuel tank selector valves were in the auxiliary tank positions. Examination of the fuel lines, fuel screens, fuel filters, and available fuel pumps revealed no restrictions in the fuel flow to the four engines or evidence of failure prior to impact. There was no evidence of mechanical malfunction, failure, or fire involving any part of the aircraft prior to impact and no evidence of crew incapacitation prior to impact. A check of the aircraft records revealed that there were between 25-50 gal. of fuel in each of the four auxiliary fuel tanks when the crew accepted the aircraft. Only the main fuel tanks were filled during the refueling operation at the Jacksonville Naval Air Station and no additional fuel was added to the auxiliary fuel tanks. Investigation and analysis of fuel samples from the servicing units and storage tanks disclosed no contamination by foreign materials at the time of servicing the aircraft.

U. S. Overseas Airlines, Inc., had the following fleet:

7 C-54-B-DC aircraft (6-Fuel Tank System)
5 C-54-E-DC aircraft (8-Fuel Tank System)

[1] All times are Eastern Standard based on the 24-hr. clock. All distances are in nautical miles and altitudes are mean sea level.

1 C-54-G aircraft (N 4000A) (8-Fuel Tank System)
2 DC-6A aircraft
2 DC-6B aircraft

All of these Douglas aircraft have somewhat similar fuel systems. Among the differences between the C-54-B and the E and G are the number of fuel tanks installed and the tank selector handle positions. The fuel selector positions for the 6-tank C-54s are: REAR—OFF; FORWARD—MAIN TANKS. The fuel selector valve positions for the C-54 8-tank system are: REAR—OFF; CENTER—MAIN TANKS; FORWARD—AUXILIARY TANKS.

The checklist in the aircraft was of the rotative type and was found set at a point indicating that it had been rolled past the following items: PREFLIGHT; ENTERING AIRCRAFT; PRESTARTING; START ENGINES; and PRETAXI. The prestarting and pretakeoff checklist section relating to fuel tank selector settings are as follows:

PRESTART—MAIN TANKS (Type System)—ON

PRETAKEOFF—MAIN TANKS (Note Type System)—ON

In addition, the following placards were found on the instrument panel above the fuel selectors:

"CAUTION—Before takeoff, check operation of each engine on all eight main and auxiliary tanks.

"Takeoff on main tanks, cruise on auxiliary tanks, then back to main tanks for landing."

The company operations manual specifies that fuel will be used out of auxiliary tanks to an indicated minimum of 50 gal. and that remaining fuel may be used one tank to an engine at a time.

No reference was found in the operations or flight manuals regarding the different configurations of C-54 fuel systems and fuel selector positions.

Capt. Reid had flown C-54 aircraft 7,303 hr., 6,500 of which were as captain. The flight records of Capt. Reid indicated that since his employment with U. S. Overseas Airlines July 21, 1958, he had completed 240 flying hours in C-54-B series aircraft and 233 flying hours in C-54-E and G aircraft. His last previous flight was in a C-54-E series aircraft.

Copilot Cole had a total flying time of 9,024 hr., of which 255 hr. were in C-54 aircraft. He had flown 69:45 hr. in C-54 aircraft during the previous 30 days. He had flown a total of 209 hr. in C-54-B series aircraft and 46:55 hr. in C-54-E and G series aircraft.

The recorded weather at the time of the accident was: broken clouds at 2,500 ft., 10,000 ft. overcast; visibility three mi. in fog and smoke. However, according to verbal statements of the captain, the actual weather was scattered clouds with visibility unlimited and the moon fully visible. A U. S. Navy aircraft circling the wreckage shortly after the accident reported weather conditions as broken clouds at an estimated 3,000 ft. and visibility 10 mi.

An analysis of all evidence indicates that the accident resulted from fuel exhaustion due to positioning the fuel tank selectors to virtually empty tanks prior to takeoff. The 25-50 gal. of fuel in each

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auxiliary tank were sufficient to take off and reach the accident site and the No. 1 fuel tank contained slightly more fuel than the others. It is also obvious that the copilot did not move the fuel selectors during the emergency, as considered possible by the captain, but mistakenly considered himself to be in a 6-fuel-tank aircraft and believed, therefore, that the forward fuel selector positions were correct for the main fuel tanks and merely made sure that they were positioned to the forward detents as found.

The flight crew suspected improper or contaminated fuel but that area was thoroughly explored and completely eliminated by the various laboratory analyses of fuel samples and investigation of airport fuel handling and dispensing. The main fuel tanks were filled to a total of 951 gal. but the four auxiliary fuel tanks were not. Only 25-50 gal. of fuel remained in each of these tanks as indicated by the gages when checked by the previous flight crew.

While it is not unreasonable for the captain to have considered the possibility of improper fuel as a reason for the loss of power, the Board believes it should not have been accepted to the exclusion of fuel starvation. Fluctuation of fuel pressure and fuel flow should have alerted the captain to the actual difficulty, particularly in view of the surging of the engines and the fact that the fuel boost pump did not remedy the condition, and the fact that the low cylinder-head temperatures eliminated the possibility of the presence of jet fuel. Switching fuel selectors to another tank should normally be one of the first acts of a pilot after a sudden decrease of fuel pressure and fuel flow.

In addition, Capt. Reid had four or more minutes to analyze his problem before impact.

Probable Cause

The Board determines that the probable cause of this accident was incorrect fuel system management, resulting in a power loss in three engines.

By the Civil Aeronautics Board:

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Member

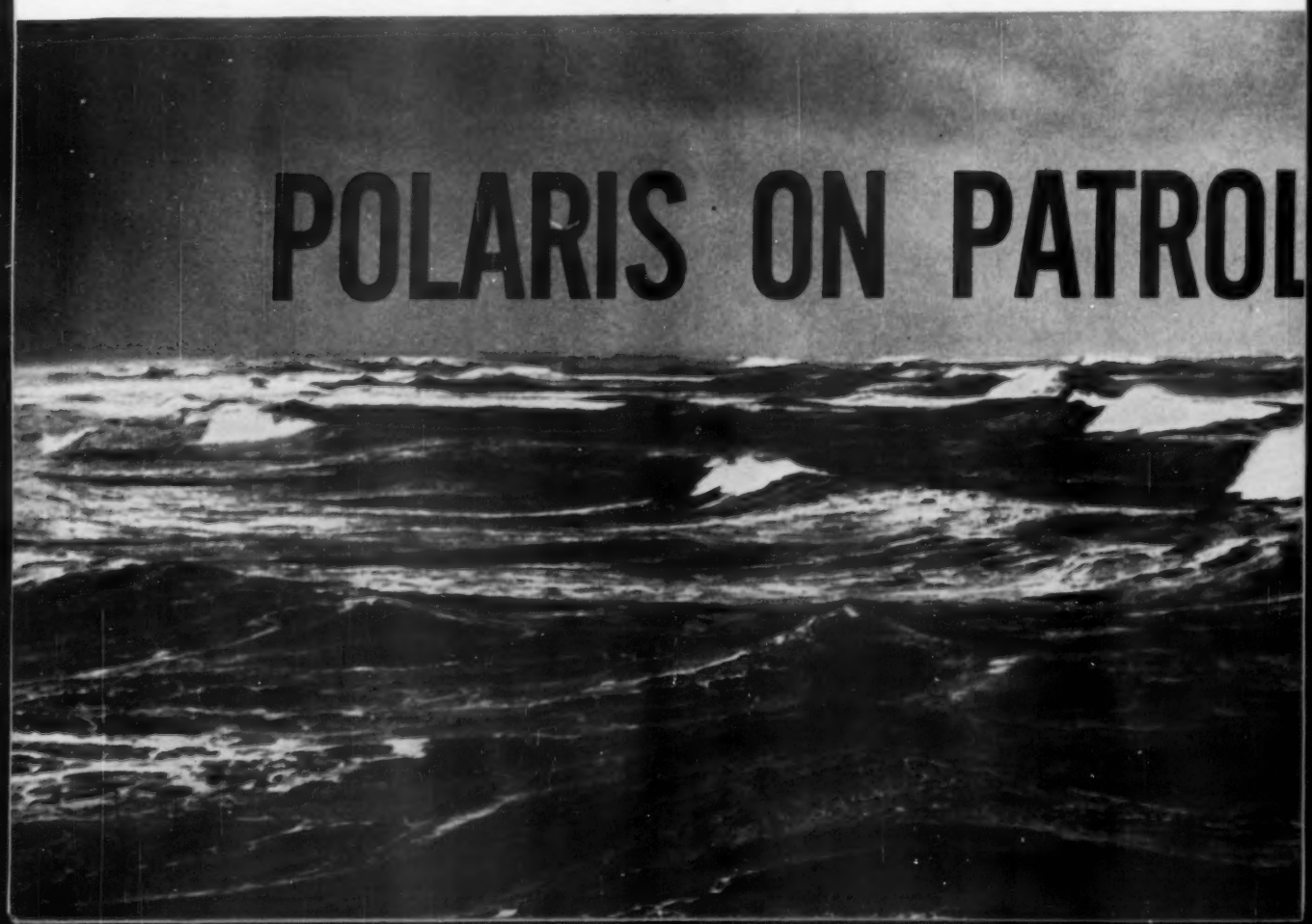
The Civil Aeronautics Board was notified of the accident shortly after it occurred. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958.

United States Overseas Airlines, Inc., holds a temporary CAB certificate of public convenience and necessity to operate as a domestic Supplemental Air Carrier which expires Mar. 30, 1961, and FAA Air Carrier Operating Certificate No. NY-1, authorizing irregular air carrier passenger and cargo operations. The carrier's principal operating and maintenance base is located at Oakland Municipal Airport, Oakland, Calif.

Capt. Jewell Reid, age 45, was employed by U. S. Overseas Airlines on July 21, 1958, as a copilot in C-54 aircraft following his retirement from the U. S. Navy where he was a naval aviator in transport-type equipment. He held a currently effective airman certificate with airline transport and other appropriate ratings. His last first-class physical was completed Apr. 3, 1959. He was upgraded to reserve captain on Feb. 6, 1959, and to captain on Aug. 28, 1959. He had a total of 12,166 flying hours, 7,303 of which were in C-54 type aircraft. He had flown a total of 216 hr. within the last 90 days, all of which were in C-54 type aircraft. He had completed the required ground school tests, instrument, and proficiency checks.

Copilot Gordon Cole, age 37, was employed by U. S. Overseas Airlines on July 16, 1959. He held an airman certificate with commercial privileges and single-engine land rating. His last second-class physical was completed July 27, 1959. He had a total of 9,024 flying hours, 255 of which were in C-54 type aircraft. He had completed the required ground school tests, instrument, and proficiency checks.

Douglas C-54-G, N 4000A, serial number 36063, was purchased by U. S. Overseas Airlines from the U.S. Air Force on Nov. 16, 1955, and was of a cargo configuration. It had a total flying time of 19,269 hr., 10,543 hr. since the last major overhaul. Nos. 1 and 4 engines were



Pratt & Whitney R-2000-D-5 twin Wasps. Nos. 2 and 3 engines were Pratt & Whitney R-2000-7M2 twin Wasps. No. 1 engine had 17,531 total hours, 895 hr. since last overhaul. No. 2 engine had 6,506 total hours, 591 hr. since last overhaul. No. 3 engine had 17,630 total hours, 799 hr. since last overhaul. No. 4 engine had 16,754 total hours, 357 hr. since last overhaul.

Turbulence May Have Caused B-26 to Crash

Washington—Possibility that severe turbulence played a major role in the crash of a Continental Can Co. B-26C on July 1, 1959 near Marion, Ohio, was raised in a recent Civil Aeronautics Board accident report.

Board investigators were unable to determine the probable cause of the accident because of the nearly complete destruction of the wreckage, but the report indicated the aircraft apparently went out of control while flying through an active line of developing thunderstorms.

Flown by Continental pilots John R. Dunham and Donald Martin, the aircraft was en route from Chicago, Ill., to Baltimore, Md. with eight company passengers, when it was seen to enter a near vertical dive from an altitude of 4,000 ft. and crash at a point about three miles from Marion and 15 mi. from the flight's planned course. Speed of impact was "extremely high," CAB said, with heavier portions of the aircraft found imbedded nearly eight feet in hard clay. Crew and passengers all were killed.

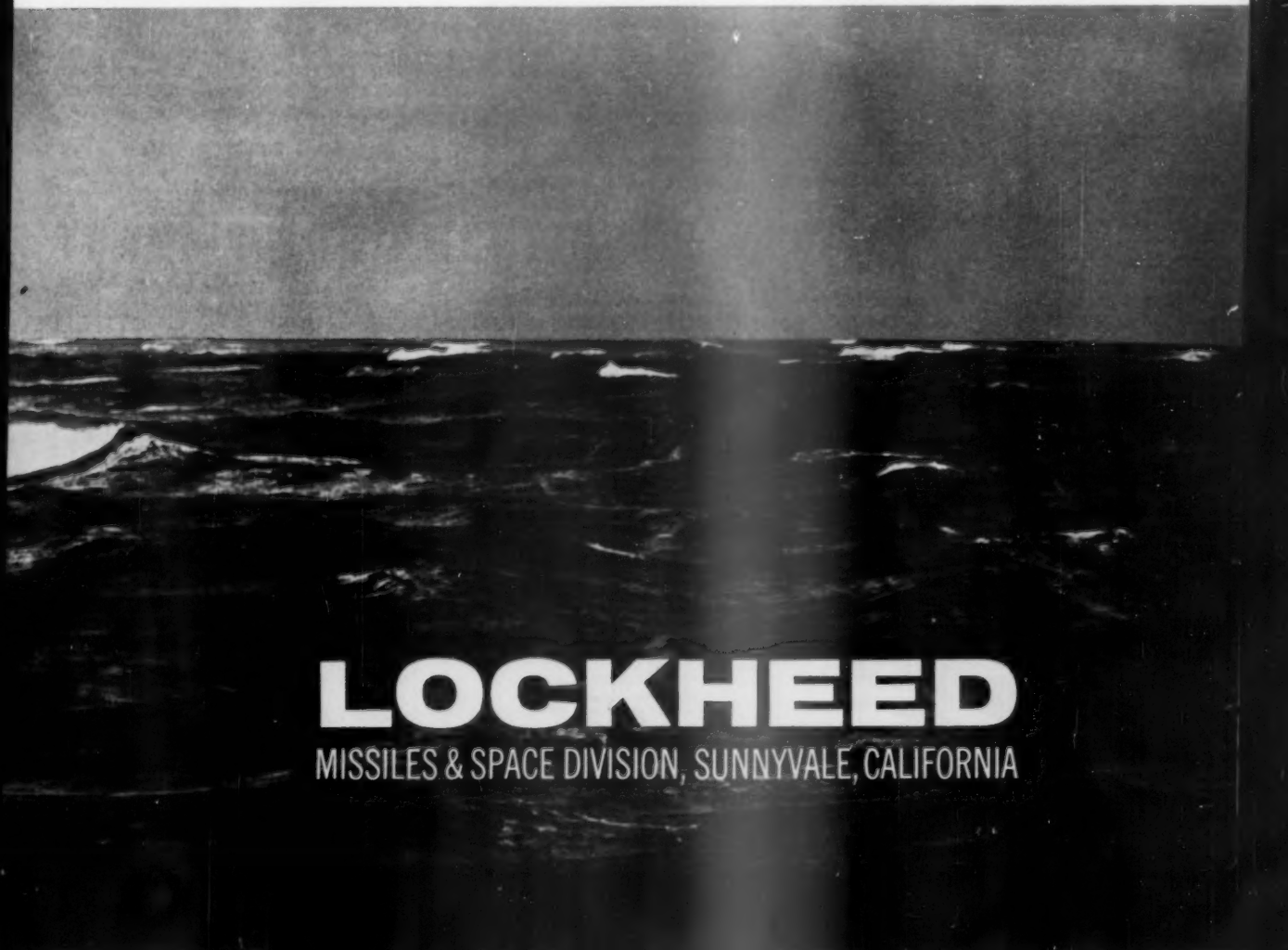
The Board found no evidence of structural, control or powerplant failure in flight, but it theorized the aircraft may have sustained structural damage, which could have caused the dive, as a result of flying through severe turbulence a few minutes before.

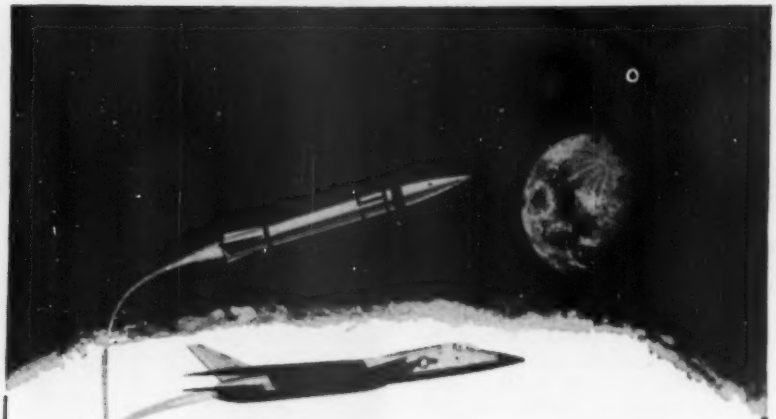
While the aircraft's course deviation may have been a pilot's attempt to avoid the worst of the weather as indicated by airborne radar, CAB investigators said they were unable to explain how or why the aircraft descended from its assigned 9,000 ft. altitude to only 4,000 ft. over Marion. In addition, they singled out the two pilots' competence as being of "high quality," with records showing that Dunham had total flying time of 10,577 hr., with 805 on the B-26, and Martin had 3,766 hr. with 1,728 on the twin-engine aircraft.

Pointing out that several "flash" weather advisories were available but not requested by the flight, CAB said it has been conferring with other government agencies and industry to assure that all flights which might encounter severe weather received the severe weather bulletins.

PanAm Skyscraper

The $100 million, 59-story skyscraper now under construction in midtown Manhattan and abutting Grand Central Terminal will bear the name of Pan American World Airways. The airline has leased 613,000 sq. ft. of space in the PanAm building. The new quarters will house executive offices, traffic and sales, reservations, engineering, communications, industrial relations, and services of supply. Occupancy is expected in 1963.





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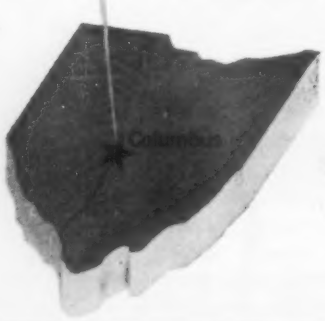

THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

WHO'S WHERE

(*Continued from page 23*)

Honors and Elections

Robert Nelson, manager of Product Support Publications in General Electric's Large Jet Engine Department, has been elected national chairman of Aerospace Industries Assn.'s Service Publications Committee.

H. B. Renwick, vice president of Canadian Pacific Air Lines, has been elected chairman of the Western Hemisphere Traffic Conference of the international airlines for the International Air Transport Assn.

John L. Buckley, security manager of United Technology Corp., has been elected president of the American Society for Industrial Security, succeeding **Eric L. Barr, Jr.**, who was elected chairman of the board. Other new officers: **Ernest E. Felago**, of General Precision Equipment Co., first vice president; **John J. Ahern**, of General Motors Corp., second vice president; **George D. Higgins, Jr.**, of Convair Division of General Dynamics Corp., secretary; **Joseph F. Doherty**, of Bell Telephone Laboratories, Inc., treasurer. Also: **Thomas J. O'Neill**, of Stanford Research Institute, and **Timothy J. Walsh**, of Sperry Gyroscope Co., elected A.S.I.S. directors.

Changes

Capt. James B. Denton (USN, ret.), director of product planning and development, Servonics, Inc., Alexandria, Va.

C. Richard Zerkle, Eastern customer liaison manager (Westbury, N. Y.) for Servomechanisms, Inc., El Segundo, Calif.

Marvin J. Bock, chief engineer, Kearfott Division of General Precision, Inc., Van Nuys, Calif.

Dr. Robert C. Brumfield, director of engineering, MHD Research, Inc., Newport Beach, Calif.

Dr. Henry L. Richter, Jr., manager of the newly formed Advanced Electronics and Information Systems Division, Electro-Optical Systems, Inc., Pasadena, Calif.

Robert C. Murrell, director-quality control, Melpar, Inc., Falls Church, Va., a subsidiary of Westinghouse Air Brake Co.

Col. Frederick A. Henry (USAF, ret.), manager of Summers Gyroscope Co.'s Dayton, Ohio, office.

Charles B. Slade, manager of United Technology Corp.'s technical liaison office in Los Angeles, Calif.

Stephen Jack, chief of Astronautics Marketing, Northrop Corp.'s Norair Division, Hawthorne, Calif.

Morris Spector, electronics staff manager, Thompson Ramo Wooldridge International Division, Los Angeles, Calif. **Frederick M. Arbuckle** succeeds Mr. Spector as head of the Patent Department of TRW's Ramo-Wooldridge Division, Canoga Park, Calif. Other Ramo-Wooldridge appointments: **C. J. Breuer**, director of administration and finance; **D. W. Gere**, manager of security.

Dr. Earl A. Long, assistant director of the John Jay Hopkins Laboratory for Pure and Applied Science, General Atomic Division of General Dynamics Corp., San Diego, Calif.

Dr. Gilford G. Quarles, director for long range military planning, The Bendix Corp., Detroit, Mich.

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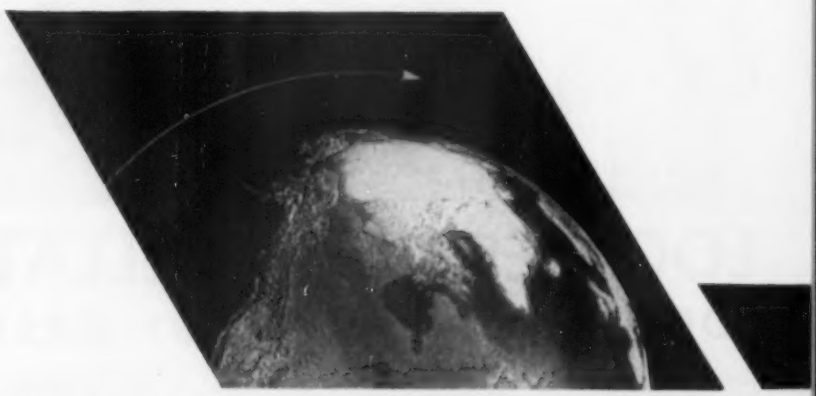

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Position & Duties		
2.		
Position & Duties		
3.		
Position & Duties		
4.		
Position & Duties		

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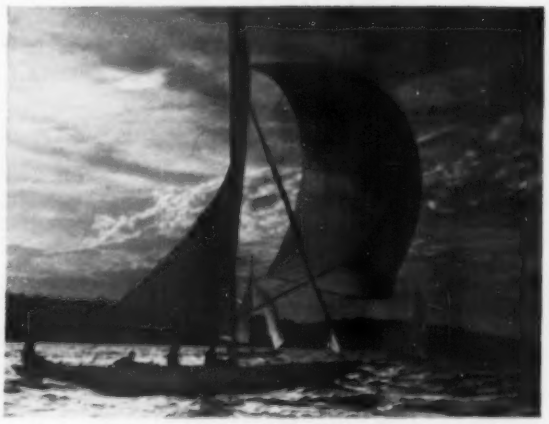

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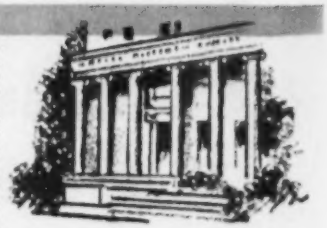

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But today, little more than nine years later, the Aircraft Nuclear Propulsion Department of General Electric has developed and demonstrated the basic technology required to build and fly a high performance aircraft nuclear propulsion system.

During the 9-year span of effort, General Electric engineers and scientists have achieved major breakthroughs in reactor technology, shielding techniques, high temperature resistant materials, specialized controls capable of functioning reliably in a high density radiation environment, and in other areas.

One of these technical achievements is discussed to the right in capsule article form. In succeeding announcements other interesting technical advances at the Aircraft Nuclear Propulsion Dept. of General Electric will be discussed.

ADVANCES IN NUCLEAR SHIELDING TECHNIQUES

As the shield is the largest weight item in the propulsion system, major effort has been applied to shield theory, experiment and design since the initiation of the Aircraft Nuclear Propulsion program.

The dimensions of the problem faced are evident when you consider that General Electric engineers had to find a way to reduce shielding weights from hundreds and thousands of tons for stationary nuclear power plants by orders of magnitude.

One of the major gains registered was the concept of the divided shield, i.e. dividing the shielding between the power plant and the crew compartment. This concept takes advantage of the fact that even the most sensitive component of the system can withstand 10,000 times the amount of nuclear radiation that a human being can tolerate.

This concept has been defined through the use of improved analytical techniques to produce detailed radiation patterns around reactor shield assemblies. New computer programs, and new calculation techniques developed at General Electric have yielded invaluable data for the design of sophisticated shielding configurations.

Additional improvements have been attained through study of materials. Materials not formerly employed for reactor use have been developed and applied. Design techniques have been created which take maximum advantage of these materials.

These theoretical and experimental investigations have resulted in shields which are so light that nuclear aircraft need be no heavier than present day airplanes. Shielding weight is no longer a critical problem.

Although much has been accomplished, further improvements in shielding technology are being developed through improved calculation methods, advanced materials development and more sophisticated structural design.

Opportunities exist today for Engineers and Scientists from many disciplines to contribute to precise solutions of a variety of sophisticated problems pertaining to the final development stage of General Electric's nuclear propulsion system for high performance aircraft.

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LETTERS

The Poor Passenger

Just read your editorial "Pity the Poor Passenger" (AW Oct. 3) after returning from a West Coast trip via jet, as my aircraft was down for maintenance.

I'll add "Amen" to what you report—you describe an average "707" domestic flight as well as foreign schedules. As the saying goes, "Time to spare; go by air—more time yet; go by jet!"

J. B. Hartranft, Jr.
Aircraft Owners and Pilots Assn.
Washington, D. C.

I was most interested and quite amused with your editorial in the Oct. 3 issue of Aviation Week concerning the Poor Passenger. Even trying not to be prejudiced, I cannot help but agree that after completing a flight one wonders who the airlines are trying to serve—the passenger or a combination of the National Association of Architects and Old Man Confusion.

After meeting a friend at the Los Angeles International Air Terminal last month, we stood at the baggage counter for 25 min. waiting to give someone the claim check. Finally, we picked up our baggage and left. I suppose I could have taken someone else's just as easily, with no one the wiser.

In reference to the design of air terminals, however, I am just a little bewildered at some of the proposed designs. Some I have seen do not allow for more than one plane to turn around simultaneously and have more material for design purposes than for efficiency. I know that the one thing I am interested in when I make a trip is to find a place to park as close as possible to the airline I am interested in, and then get there as fast as possible without being crushed in the stampede. The solution to the combined design and parking problem seems to me less difficult than I have read. Why not design a toroidal terminal building with radial spokes for loading and provide a tiered parking lot in the center? Expansion could be vertical and the main vehicle entrance, of course, would be underground.

The bus lines and railroads seem to have solved, in part, their ticket problems with "charge-a-plate" type blanks for standard point to point trips. Why can't the airlines? Of course, including the prices on these blanks would be uneconomical since they rise monthly.

Ens. William V. Goodall, USNR
Naval Missile & Astronautics Center
Pt. Mugu, Calif.

Your editorial in the Oct. 3 issue of Aviation Week on airport problems hits the nail on the head!

As the editor of the leading aviation publication, your words are certain to get attention and passengers everywhere will be grateful to you for help in bringing attention to the problem.

O. L. Dewey
Manager, Electronic Services Division
Raytheon Co.
Burlington, Mass.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Synchronous Satellite

Reference is made to your article entitled, "Bendix Analyzes Satellite Orbit Coverage" in the Sept. 5 (p. 88) issue of Aviation Week.

The statement is made both in the text and under one of the illustrations that a synchronous satellite crosses the equator every 6 hr. By definition, a synchronous satellite circles the earth once every 24 hr. Therefore, a satellite of this type, whose orbit is inclined to the equator, crosses the equator every 12 hr.—not every 6 hr.

Melvin Shorr
Technical Operations Branch
Aeromechanics Division
Wright Air Development Division
ARDC
Wright-Patterson AFB, Ohio

(Reader Shorr is correct. The synchronous satellite crosses the equator once every 12 hr., regardless of its orbital inclination. —Ed.)

Pulse Radiation

Thank you very much for the recent article on nuclear pulse radiation in the Avionics section of the Aug. 8 issue (p. 58) of Aviation Week. The information presented in this article, coupled with the recent conference on pulse radiation testing, sponsored by the Air Force at the Air Force Special Weapons Center in Albuquerque, has helped to point out the need for further understanding of transient radiation effects.

We feel that this is an area where much experimental work remains to be done and where considerable challenge is presented to physicists and other scientists working in the fields of solid state and electronics. In addition, we recognize the importance of having good, reliable laboratory tools to permit experimental work in these areas to be done safely. In this regard, we would like to call your attention to a source of pulse radiation which has been designed by Atomics International in order that transient radiation testing may be performed on a routine and safe basis.

This pulse source is known as the Solution Type Pulse Reactor (STPR). It is based on the same reactor concept as the many homogeneous research reactors which have been designed, constructed and installed by Atomics International and are operating today in various parts of the world. The STPR will produce pulses of 10^{16} neutrons/cm^2 and 10^6R of gamma radiation, with total energies of 8-10 megajoules, pulsewidths of 3.0-3.5 milliseconds at the half-maximum point, and peak powers of approximately 2,300 megawatts.

In addition to favorable nuclear radiation characteristics, the homogeneous reactor offers advantages of unquestionable reliability and safety.

Extensive safety investigations, conducted by AI under the AEC-sponsored program "Kinetic Experiments of Water Boilers," have conclusively demonstrated this point. During these tests, the reactor was safely pulsed at periods of less than one millisecond. These tests typify the overwhelming safety characteristics of the STPR since the periods involved are five times as short as those which could cause damage or destruction to most heterogeneous thermal reactor assemblies.

We are confident of the ability of the STPR to meet the general requirements of pulse radiation testing more favorably than other reactor concepts which may be operated by pulse sources. We will welcome inquiries regarding the characteristics of the STPR, its safety, cost, or its applicability to transient radiation testing.

W. M. Haussler
Atomics International Division
North American Aviation, Inc.
Canoga Park, Calif.

Nerve Gases

The article in the Sept. 5 issue of Aviation Week—"Army Presses Nerve Gas Development" (p. 32)—indicates the need for a new philosophy in weapon system development. Until now our retaliation and deterrent systems have been based on the "total" or "mass" destruction and slaughter weapons. For a nation as advanced in technology as ours, this concept smacks of Neanderthal crudeness. When one considers the religious, ethical, and moral tenets this country was founded on, the mass slaughter weapon becomes a hypocritical method to obtain this end.

Gas and bacteria mediums may provide a means by which an enemy could be incapacitated for periods of time that would permit resistance to be overcome without huge loss of life. These mediums can be deployed by the same tactics and delivered by the same weapon systems now used for mass slaughter systems. When the development of these systems reaches the technical adequacy required to provide the same deterrent and retaliation capability needed for our own survival in the Cold War, it would then be practical to outlaw the "A and H" bomb weapons. With these mediums the United Nations could enforce world peace and we could utilize the propaganda gained from including this capability in our weapons inventory in renewing world respect for our way of life.

Now is the time for the Defense Department to combine our resources and existing programs of this type under one weapon system concept to develop the needed weapons, strategy, and the tactics for our armed forced to wage "humane" warfare.

Richard A. Vrooman
Los Angeles, Calif.

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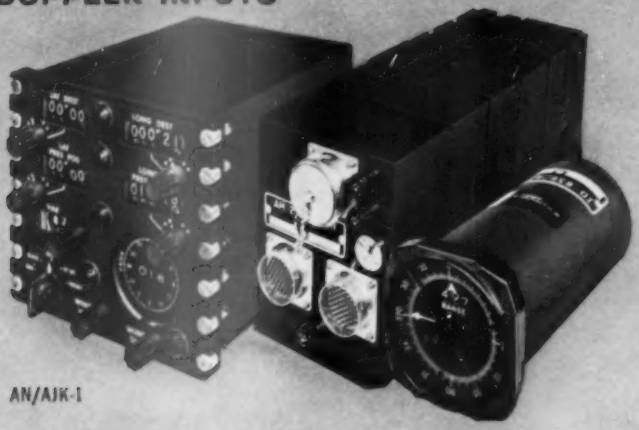

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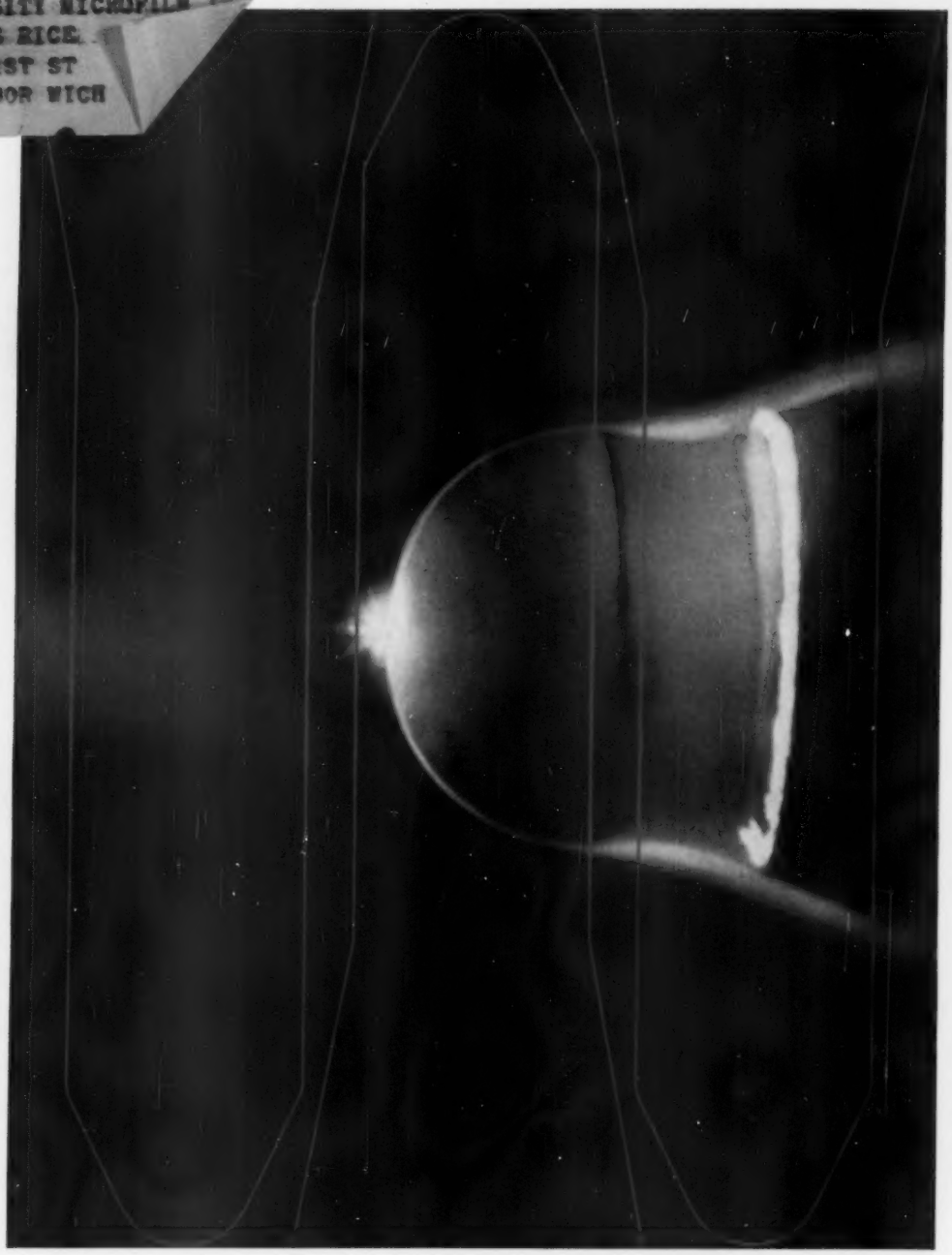

Blasting new materials to make missile nose cones. The first ICBM nose cone ever to be recovered after flight was protected by a new, high-temperature material. Its name: Avcoite. Its construction: specially reinforced ceramic. Avcoite was the first of a family of new heat-shielding materials. They were developed for re-entering nose cones and satellites by Avco's Research and Advanced Development Division. Newest addition to this materials family is Avcoat, a plastic heat-shield here ablating smoothly in a hydrogen-oxygen jet simulating satellite re-entry temperatures.

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